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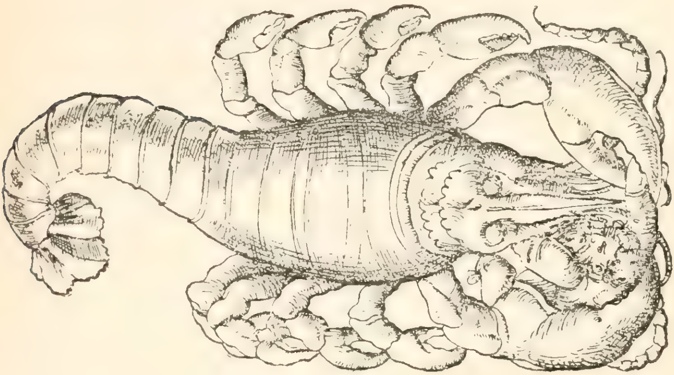

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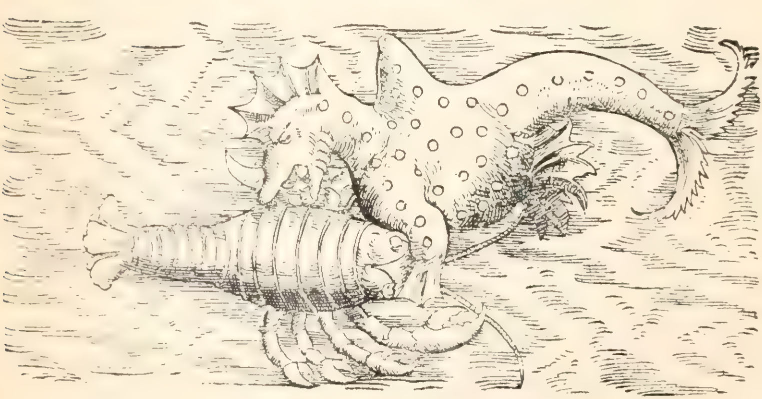

A HISTORY

OF

CRUSTACEA

RECENT MALACOSTRACA

BY THE

REV. THOMAS R. R. STEBBING, M.A.

FORMERLY FELLOW AND TUTOR OF WORCESTER COLLEGE, OXFORD
AUTHOR OF 'THE NATURALIST OF CUMBRAE'
'THE CHALLENGER AMPHIPODA' ETC.

WITH NUMEROUS ILLUSTRATIONS

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PREFACE

The ambition of this volume is that it shall be one to which beginners in the subject will naturally have recourse, and one which experienced observers may willingly keep at hand for refreshment of the memory and ready reference. An attempt has been made in it to bring the reader face to face with the vastness of the theme, to show him how variously it may engage the human mind, and to give him a groundwork of information as to the objects to be examined, with a side glance at the literature that has discussed them.

It is not very generally known that the species of Crustacea extend to a number of several thousands, and that some of these species people parts of the ocean in enormous swarms. Of some of the groups the general character is familiar to every one, but there are also groups of which most persons either know nothing or have not the least idea that they belong to the Crustacea. The beginner, therefore, will have provinces of a new world opened to his exploration. There is curiosity to be gratified. The sporting instinct will discover many an unexhausted territory. In the manners and customs

of the creatures there is much to afford entertainment, and almost every new observer finds something singular to relate.

In examining the structure both external and internal, whether in new species or in those that have been long established, the acutest powers of observation may be trained and profitably employed. Moreover, the highest ingenuity is excited and finds scope in the effort to explain the meaning of the facts observed. For, judging by discoveries already made, we are warranted in supposing that, down to the finest hair, every detail of every organism has its motive and meaning. Nor need man despair of finding out something for his private and personal benefit while investigating the physiology of a shrimp.

It is needless to insist that a hundred volumes such as the present would not suffice to discuss the subject in all its bearings, since a hundred volumes would be but a small fraction of what has been already written upon it, and the incessant stream of publications widens and deepens as it flows.

By the references made to some of the most recent and to some of the most important authorities, the student will be guided in general to adequate lists of literature. In consulting these bibliographical notices he will be perhaps as much amazed by the multitude of writers and writings as at first by the multitude of the genera and species of the Crustacea themselves. He will be led to consider it not unreasonable that the present volume should have been content to deal with one half of the entire class, leaving the other half for a future occasion.

He will recognise by a perusal of the mere titles of what has been written, that no manual of this size could cope with all the branches of the subject, without the certainty of becoming a dry and repulsive catalogue. Even in what has been here laboriously put together the gentle reader is requested to remember that definitions are like the sermon which the preacher was forced to deliver, but to which, he reminded his hearers, they were under no sort of compulsion to listen. A time comes to the student when he scans every word of a definition with eager interest, but till then it will do him no harm to pass it over with cursory eyes and a light heart.

In a volume of the International Series it would have been inappropriate to devote to the British fauna more than its proportional space, but I have thought that it would be neither unfair nor uninteresting to mention at least the names of all the British species, so far as it has been possible for me to collect them from and correct them by the latest and best authorities.

One personal matter remains to be noticed. It was long the intention of Dr. Henry Woodward, of the British Museum, to publish in this Series a 'History of Recent and Fossil Crustacea.' The continual pressure of other engagements has prevented him from accomplishing the congenial task. That, nevertheless, the results of his unrivalled knowledge of the extinct forms will sooner or later be gathered into a compendium for general use should be taken for granted. The other materials which he had collected for his purposed work, relating principally to the characters of the living organism, are still in reserve

for the service of a future volume. In the meantime the production of the present book was entrusted to my hands at his express desire. A circumstance so honourable to myself and so well fitted to inspire an initial confidence in my readers, it would, I think, be false modesty to conceal. My best thanks are due to Dr. Woodward for his friendly and favourable opinion of my capacity; they will be best paid if my performance has succeeded in deserving it.

THOMAS R. R. STEBBING.

TUNBRIDGE WELLS,
February 17, 1892.

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ILLUSTRATIONS IN THE TEXT

The names in italics indicate the sources from which the figures have been copied or adapted. The Brachyura of the *Challenger* were described by Mr. E. J. Miers, the Anomura by Dr. J. R. Henderson, the Macrura by the late Mr. C. Spence Bate, the Cumacea by Professor G. O. Sars, the Isopoda by Mr. F. E. Beddard. The other pictorial authorities are Gesner's 'Historia Animalium,' Herbst's 'Naturgeschichte der Krabben und Krebse,' Desmarest's 'Considérations générales sur la classe des Crustacés,' de Haan's 'Crustacea' in von Siebold's 'Fauna Japonica,' and various papers of modern date by G. O. Sars, S. I. Smith, C. W. S. Aurivillius, H. J. Hansen, C. Bovallius, C. Chilton, MM. Giard and Bonnier, R. Kossmann, W. A. Haswell, and Victor von Ebner.

For the text, as distinct from the illustrations, many other authorities would have to be named, but the text will speak for itself.

As to the reproduction, on a scale suitable to these pages, of figures so numerous and so diversified from originals neither equal in merit nor uniform in style, I am indebted to Mr. James D. Cooper for the care and skill exhibited in carrying out a task of no mean difficulty.

A HISTORY

OF

RECENT CRUSTACEA

THE MALACOSTRACA

CHAPTER I

OUTLINE OF CLASSIFICATION

It is conceivable that by origin all the animals of the globe belong to a single family. They now exhibit very great divergence. Between a star-fish and a crocodile, for example, the cousinship is obscure and remote. Yet almost all species may be included within a few principal clans, and these are united one to another by a small number of intermediate forms of life. For the whole series the details of classification will vary with the increase of knowledge. No system has yet been accepted as final. One, which is sufficiently good for our present purpose, distributes animals among nine leading divisions. These are (1) the Protozoa, primitive animals, such as the Foraminifera and Infusoria; (2) the Cœlenterata, in which the body-cavity serves alike for circulation and digestion, a tribe which includes sponges, corals, and jelly-fish; (3) the Echinodermata or prickly-skinned animals, embracing the sea-lilies, star-fishes, sea-urchins, sea-cucumbers, and a

wormlike genus called *Balanoglossus*; (4) the Vermes or Worms; (5) the Arthropoda; (6) the Mollusca, among which are the well-known oyster, snail, and cuttle-fish; (7) the Molluscoidea, containing the mollusc-like lantern-shells, and the grouped animals of the Polyzoa, in some of which the so-called 'bird's-head' organs amuse the observer; (8) the Tunicata, the tunic-clad or mantled animals, comprising the Ascidians, whether tough-coated or gelatinous, and the Salpæ which roam the sea in alternate generations solitary or connected in a chain; (9) the Vertebrata, with the important classes of fish, amphibians, reptiles, birds, and mammals.

It is with the central group of these nine that we are here concerned. So far as the name goes the Arthropoda are animals with jointed limbs. So far as the name goes, therefore, cats and dogs and vertebrates in general might belong to this division. But the name was given with reference not to the vertebrates, but to the vermes, for originally the worms and arthropods were included in a division called the Annulosa, animals of which the bodies contain several annuli, rings, metameres, somites, zonites, arthromeres, or segments, as they are variously called. These two sections of the Annulosa are now severed, and are distinguished by the circumstance that the one is, and the other is not, provided with jointed limbs.

The Arthropoda are defined as animals which have bodies composed of variously shaped segments; which have jointed appendages attached to some at least of the segments; which have (in general) a brain united to a ventral nerve-cord, or ganglionic chain, and which exhibit bilateral symmetry.

None of the other divisions will be found to possess all these characters combined. For example, in the vertebrata the nerve-cord is dorsal, in the mollusca the body is unsegmented, in the vermes there are no jointed appendages. Instances, it is true, are to be met with of arthropods which do not themselves answer the requirements of the definition, instances in which the body is unsymmetrical or unsegmented, and in which there are no articu-

lated limbs. But in all these instances there is a period of life when the creature possesses, though it subsequently loses, the characters which determine its place in classification.

Under the Arthropoda are included five classes, two of which are of very prominent importance in the economy of the world. The five classes are the Crustacea, Pycnogonida, Arachnida, Myriapoda, and Insecta. A sixth class, the Onychophora, is sometimes added for the sake of the peculiar genus *Peripătus*, but for the present it may be as well to give this the rank of an order among the myriapods, a class represented by the familiar but unfavoured centipede. The Arachnida contain spiders, scorpions, mites, as well as some other less commonly known groups.

The Pycnogonida (or Pantopoda), the sea-spiders, at one time included in the Crustacea and at another time in the Arachnida, have some remarkable peculiarities, inasmuch as the ovaries of the female are found as a rule not in the trunk of the body, but in the thighs of the legs, and when the eggs are laid they are usually carried about not by the mother but in packets upon the oviferous feet of the male.

The Insecta are so strikingly distinguished by the special number of their legs that this class sometimes receives the name Hexapoda, the six-footed animals. Beetles, bees, bugs, flies, fleas, moths, spring-tails, earwigs, grasshoppers, and gnats, in countless profusion people the globe, sometimes disputing possession with man himself or rendering his life a burden, at other times offering him service direct or indirect of no mean value. It is in this class, and in this class only, that the present state of science reckons the number of species not only by scores of thousands but by hundreds of thousands, and even by millions. The class which stands nearest to the Insecta in the multitude of known species is that of the Crustacea, but the interval is so vast that, properly speaking, the Insecta are in this respect first with no second.

Of the numerous definitions which have been given of the Crustacea, it will be sufficient to quote two. According

to one of these, they are 'Aquatic Arthropoda, which breathe by means of gills. They have two pairs of antennæ, numerous paired legs on the thorax, and usually also on the abdomen.' This is compendious and useful. The statements clearly exclude all the other classes of the Arthropoda. They are also widely applicable among crustaceans; yet of these animals there are some which are not aquatic, some which have no gills, some which have not two pairs of antennæ, and some in which the 'paired legs on the thorax' are not numerous.

A different definition was given by Professor Alphonse Milne-Edwards in 1860, according to which the class of Crustacea comprises 'all the segmented animals with branchial or cutaneous respiration, in which the body is provided with jointed limbs, whether permanent or transitory.' The Insecta and Myriapoda breathe by means of the air-tubes called tracheæ; most of the Arachnida by means either of tracheæ or pulmonary sacs known as fan tracheæ. From all these, therefore, the definition separates the Crustacea in a satisfactory manner, even though some terrestrial Crustacea combine tracheate with branchial respiration. There are, however, some subordinate members of the Arachnida, and the whole class Pycnogonida, in which the respiration is dependent on the surface of the body and not on any special organs. As it is only in recent years that the Pycnogonida have been constituted an independent class, it was no fault of a definition framed in 1860, that it included them among the Crustacea, to which they were then supposed to belong. They are in fact separated by many characters, one of which is the possession of a proboscis, which is supposed to have originated in the coalescence of the upper lip and the mandibles. So far as is known, they are all marine animals. On the other hand, those Arachnida which have surface-respiration are apparently all air-breathers. To meet all existing requirements, then, the definition of the Crustacea may be framed in the following manner:—

They are Arthropoda without terminal proboscis, with respiration branchial or cutaneous, the latter only aquatic.

It is not to be expected that any legitimate definition

of an extensive class will be largely descriptive, because many features of wide range and great prominence are likely to be missing in outlying and erratic members of the group, and these consequently have to be passed over unnoticed, in favour of less conspicuous, and of alternative, or even of negative characters.

The name Crustacea is a Latin word of old standing. Another and probably the original form of it is Crustata. The animals clothed in a crust, a covering of more or less flexibility, were distinguished by the ancients from the Testacea, in which the *test*, as in the example of an oyster-shell, is hard and rocky, and like a potsherd more ready to break than to bend. Dr. Johnson was of opinion that if the terms of natural knowledge were extracted from Lord Bacon's works, few ideas in that branch of learning would be lost to mankind for want of English words in which they might be expressed.[1] Modern science would be much hampered by such a limitation of its verbal resources. Johnson's own dictionary during the last century does not recognise the substantive, a crustacean. The adjective, crustaceous, it thus defines: 'Shelly, with joints; not testaceous; not with one continued, uninterrupted shell. Lobster is *crustaceous*, oyster testaceous.' The same dictionary defines and illustrates the word crab as follows:

'A crustaceous fish.

'Those that cast their shell are, the lobster, the *crab*, the crawfish, the hodmandod or dodman, and the tortoise. The old shells are never found, so as it is like they scale off and crumble away by degrees.—*Bacon's Natural History*.

'The fox catches *crab* fish with his tail, which Olaus Magnus saith he himself was an eye-witness of.—*Derham*.'

Shellfish, crayfish, and crawfish, are expressions still in use, although the term crab-fish is no longer in fashion. The uncritical ages had a tendency to regard as fish most animals which came out of the sea, and a story is told of a cook who persuaded her Hebrew mistress that a sucking pig became for all practical purposes a fish by being made

[1] See *A Dictionary of the English Language*. Preface. Eighth Edition. 1799

to run a few steps into the ocean and out again. With a similar effort of the scientific imagination, the illustrious Erasmus Darwin, when a schoolboy, excused himself for eating roast goose during Lent by the scriptural axiom that 'all flesh is grass,' and the goose therefore a species of vegetable.

So far as the name Crustacea implies a covering of any considerable toughness, it is little applicable to some of the parasitic members of the class, but in general much more confusion than advantage follows from the displacing of long-established names in the effort after absolute accuracy. If we are never to use the scientific designation of a group unless it exactly applies to all the members of it, then what is to be done, one writer rather maliciously asks, in the case of the species called Homo *sapiens*?

A general though not a complete agreement prevails in regard to the external boundaries of the crustacean class. The proper mode of subdividing it and the arrangement of the subdivisions are subjects still open to much discussion and dispute. Any final decision depends upon questions of genealogy which have yet to be answered. In the mean time four sub-classes may be accepted, under the names Gigantostraca, Malacostraca, Entomostraca, and Thyrostraca. The Gigantostraca, or giant-shells, are the oldest in known lineage, and, as the name implies, foremost in the average of magnitude. They seem to be tending to speedy extinction. The Malacostraca include forms highest in development and of most direct value to mankind. The Entomostraca probably surpass the rest in multitude of individuals, if not also of species, but are the smallest in average size. The Thyrostraca, commonly called Cirripedia, though they fall short of the Entomostraca in numbers, excel them in bulk, and are even more remote in outward appearance from any general idea of a crustacean, such as the better known malacostracan lobster, or the crab fish, might suggest.

The Greek word Malacostraca, meaning soft-shelled animals, is practically equivalent in sense to the Latin

word Crustacea. Like that, it was originally adopted to distinguish such creatures as crabs and crawfish and prawns from such others as oysters and clams; not because of the absolute, but because of the comparative softness of their shells. Were reasons wanted for displacing the name, they would not be difficult to find. Many of the Malacostraca have shells harder instead of softer than those of some Mollusca. In some Malacostraca the integument has ceased to be of the nature of a shell, a parasitic habit having cancelled the need for such a defence. Moreover, the term suggests a false contrast with the neighbouring sub-class of the Entomostraca, in which as a rule the shells or skin-coverings are still softer. The name Thoracipoda, not open to any of these objections, has been proposed by Dr. Henry Woodward. But against this it may be urged that, by many students of the Crustacea, the word thorax is not admitted as a proper technical term, and among others it is disputed whether the word, if admitted, should apply to three, to seven, to eight, or even to nine, of the crustacean segments.

Retaining, therefore, the ancient, familiar, and sufficiently euphonious word Malacostraca, the subdivisions of this sub-class may next be considered. Two orders have been formed, named respectively the Podophthalma, or stalk-eyed, and Edriophthalma, or sessile-eyed, crustaceans. In the former the eyes are mounted upon stalks or peduncles, which are almost invariably movable; in the latter they are in continuity with the general surface of the head, or, if raised above it, the ocular prominences are unjointed and immovable. That some species in both orders are blind, gives a certain vantage-ground for the disturbers of accepted names to follow their bent. These may also allege that the terms just explained have not been at any time in undisputed possession. The Podophthalma have also been called Decapŏda, ten-footed, while the Edriophthalma have been called Tetradecapŏda, or fourteen-footed, Crustacea. The second of these names has found but little favour, and the first has the disadvantage that it would apply to some Crustacea that are

not podophthalmous, and does not apply to others that are. Instead of Podophthalma or Decapŏda, Burmeister proposed Thoracostraca. To this, however, the objections already urged against Thoracipoda will apply, with the additional one, that the word has a termination which had been already employed in two, and has since been employed in the third and fourth of the higher groups. Some purists correct the word Edriophthalma, in accordance with its derivation, into Hedriophthalma. They may correct on the printed page, but who can guarantee that they will have their cherished aspirate pronounced?

The stalk-eyed Crustacea are portioned out into four sub-orders: 1. The Brachyūra, or short-tails, such as the edible crab; 2. The Macrūra, or long-tails, such as the common lobster, prawn, and shrimp; 3. The Schizopŏda, or cleft-footed crustaceans, in certain points of structure so near to the prawns and shrimps that at least one author of eminence classes them among the Macrūra; and 4. The Stomatopŏda, with feet converging about the mouth, creatures abundant in some waters, but rare in those that wash the shores of Great Britain. A fifth sub-order, the Anomūra, or irregular-tails, has long been accepted, but modern classification is disposed to distribute its members, which include the hermit crabs and others of very curious habits, between the Brachyūra and the Macrūra, from which they may be supposed to have respectively diverged, yet without losing all trace of family connection.

The sessile-eyed Crustacea are at present divided into three sub-orders, the Cumacea, Isopŏda, and Amphipŏda. The Cumacea seem to have entirely escaped the notice of the ancients, and among the moderns an accurate knowledge of their singular structure is not too widely diffused. One of the genera earliest brought into notice received the name of *Cuma*, a wave, and from this was formed the designation Cumacea for the whole sub-order, which is exclusively marine. The Amphipoda, which are common in fresh as well as in salt water, were so named by the French naturalist Latreille, as having feet extending in all directions, their limbs at the same time having much diversity

of form in correspondence with diversity of function. The Isopoda, or equal-footed animals, besides being found both in fresh and salt water, have more decidedly than the Amphipoda extended their range to the dry land. The name was invented by Latreille in ignorance of the great number of species since investigated in which the feet are strikingly unlike and unequal. Nevertheless the name may stand, just as a rose remains a rose even when it is not rose-coloured. To these three sub-orders some authors are disposed to add a fourth, the Tanaidea, while others, though agreeing to withdraw these animals from their old position among the Isopoda, would prefer to place them among the Amphipods. The need for the change in either direction has not yet been established.

The Entomostraca, by their name, which literally means testaceous insects, bear witness to an era in classification when not only they but all other crustaceans were arranged among the Aptera or insects without wings. As the forms are multitudinous and very frequently microscopic, and as moreover crowds of the species have only been made known within recent years, it is not to be wondered at that the internal arrangement of this sub-class, like that of the preceding one, is still open on some points to discussion, although there is a fair amount of agreement as to the main lines of division. The method here followed distinguishes three orders, the Branchiopŏda, Ostracōda, and Copēpŏda. By Latreille the name Branchiopoda was applied to the Entomostraca at large. It signifies branchial-footed, or animals in which the feet are in one way or another adapted to serve the purpose of respiration. This order is subdivided into four sub-orders. 1. The Phyllocarĭda, literally leaf-shrimps, derive their name from the laminar or leaflike expansions with which their legs are provided. 2. The Phyllopŏda, the leaf-footed ones, owe their name to the same characteristic, although by other features they are distinguished from the Phyllocarida. None of the Phyllopods are marine, although a few inhabit brackish water or strong brine. 3. The Cladocĕra, which are so called from their branched antennæ, occur chiefly

in fresh water, where they are common, but inconspicuous, and to the ordinary observer little suggestive of the crustacean type. 4. The Branchiūra, represented by the carp-lice, are so designated from having a branchial tail which actively assists in the function of respiration.

The Ostracōda, a title which might be interpreted as the testaceous Crustacea, may be easily mistaken for minute bivalve mollusca. Like the Branchiopŏda they are divided into four sub-orders, the Podocōpa, Myodocōpa, Cladocōpa, and Platycōpa, in which names words meaning feet, muscles, branch, and broad, are respectively compounded with the Greek word signifying an oar.

The Copepoda point at once to a connection with the preceding order, inasmuch as there one of the sub-orders derived its name from words signifying a foot and an oar, while the Copepoda are indebted to the very same components, in the inverse order of an oar and a foot. The actual structure of the animals to some extent justifies this similarity of names, but in general appearance the Copepoda, not being shut up in two-valved shells, are widely different both from the Podocopa and the rest of the Ostracoda. Three sub-orders are formed: (1) the Gnathostŏma, having the mouth well provided with jaws; (2) the Pœcilostŏma, in which the mouth varies; (3) the Siphonostŏma, having the mouth produced into a siphon or tube.

The Gigantostraca are as rare as the Entomostraca are common. They are divided into three orders, the Merostomăta, Xiphosūra, and Trilobīta. Of these, the first and third are entirely extinct, so that the knowledge of them is derived only from fossil remains.

The Merostomata have a name derived from two words, meaning a thigh and a mouth, this singular combination alluding to the no less singular fact that in these animals the mouth is surrounded by a group of limbs which are not only locomotive and prehensile, but also subservient to mastication. This peculiarity belongs likewise to the Xiphosura, or sword-tails, which are named from the long and sharp piece at the end of the body, their characteristic

tail-spine. Some authorities hold that this order should be removed from the crustacean class to that of the Arachnida. The name of the third order, the Trilobita, refers to the circumstance that they usually have the body divided by two longitudinal dorsal grooves into three lobes. They were extremely abundant in bygone ages, and the naturalists of the *Challenger* were continually in hopes that they might obtain a living specimen or two from hitherto unexplored abysses of ocean. But extinction appears to have done its work with great thoroughness upon this order.

The last of the sub-classes consists of the Cirripedia or curl-footed animals. The alternative name Thyrostraca, meaning 'valve-shells,' has the merit of agreeing in termination with the names of the other three sub-classes. But it must be admitted that if it is objectionable to call the whole group cirripedes when some have no cirri, it is equally inappropriate to call them all 'valve-shells' when some have no valves. It is a triumph of the present century in minute investigation and comparative anatomy, that has withdrawn the Cirripedes from the zoophytes, worms, and molluscs, among which, at various times, the older naturalists placed them, and that has given them henceforth an undoubted position among the Crustacea.

They may be divided into five orders, or the first two, the Pedunculata and the Operculata, may be grouped together as divisions of an order hitherto designated Thoracica, in which the part called the thorax is provided with cirri. The Abdominalia have the cirri only on the so-called abdomen. The Apoda are without cirri, being, as their name implies, footless. Lastly, the Rhizocephăla are a parasitic set, which send rootlike filaments into the bodies of their hosts.

CHAPTER II.

SPECIMENS

Collecting

To study adequately any branch of natural history, it is essential to have specimens. Many exemplary forms of Crustacea are not difficult to obtain. Representatives of the two highest orders in the group, the crab, the lobster, the prawn, the shrimp, are exceedingly familiar, as these creatures lie on the fishmonger's board, or are brought to table for food. When the eatable parts have been consumed or otherwise removed, the débris is still of value for mental nourishment. This refuse may be made to yield more profit and pleasure than many a costly collection which can only be viewed intact. By carefully separating the constituent parts of the head, the trunk, and the tail, in each of the crustaceans above mentioned, and comparing them piece by piece, the beginner will be able to give himself a cheap but invaluable lesson. He will be surprised at first to detect likenesses in the corresponding parts of animals externally very distinct, and afterwards he will be surprised at the differences in the corresponding parts of animals which he has learned to regard as closely connected. As his range of study widens, he will find relationships established between forms which, to any one unacquainted with the intermediate links, must seem to have absolutely nothing in common. For instance, while examining the gills of a lobster, he may chance to observe some small orange-coloured specks, and may rightly conjecture that these are parasitic animals. But it is scarcely conceivable that any amount of genius would

enable a man to discern, from a comparison of the lobster alone with its entomostracan parasite, that they are alike crustaceans, which is, nevertheless, known to be the case. In a dishful of prawns it may often be noticed that one or two of the finest have the head swollen on one side, as if the creature were suffering from a face-ache. There is no special reason to suppose that the prawn thus affected is suffering any great inconvenience. It is merely lending the shelter of its carapace to a family of isopod crustaceans. Comfortably ensconced in the bulging cheek-piece will be found a misshapen animal of no inconsiderable size, in general laden with innumerable eggs, and accompanied by a far smaller partner, the father of the brood, symmetrical in form, and retaining some of the freedom of movement which belongs to the young when first hatched, but which the mother has entirely resigned. Thus the zoology of the breakfast table will supply examples of three very distinct orders. These examples are none the less curious because they happen to be common. Any one who is content to examine them with care will thereby lay a simple and solid foundation for all subsequent study in the realm of carcinology.

The novice, however, need not be dependent on the fishmonger for specimens. In cellars, gardens, hedges and ditches, under flat stones, in dry moss, among moist dead leaves, in the loosened decaying bark of trees, crustaceans are to be met with almost everywhere. These are the so-called wood-lice, including those known by the trivial names of Pill-bugs and Slaters, Millepedes, and Carpenters. One species, small and white and slow in movement, is frequently to be found in ants' nests, and seemingly never elsewhere. All this set of animals, though air-breathing and living on land and often possessing great agility, belong to the Isopoda in common with the marine species above mentioned that leads its apathetic life within the carapace of the prawn.

From almost every little brook and pond in England the amphipod, *Gammarus pulex*, and the isopod, *Asellus aquaticus*, may be fished without difficulty and without

any stint of numbers. Less commonly the innocent well-shrimps, which are also amphipod crustaceans, may be obtained from wells. It may be proper to mention that the well-shrimp is not poisonous, and that it flourishes in water which is perfectly wholesome. A different view of its character is probably entertained by many owners of wells, who are on that account unwilling to mention or acknowledge its presence. From stagnant ponds various species of Entomostraca may be obtained in vast abundance. Some of the Phyllopoda are found only in brine pools. The brine shrimp, *Artemia*, breeds in vast numbers in the mud of the great Salt Lake of Utah. In South America one of the Ostracoda very singularly dwells on the leaves of a plant. The river crayfish and crustaceans parasitic on freshwater fish are pretty widely distributed. Highest in known range of all the Crustacea are the Isopods and Amphipods taken by Mr. Whymper at a height of 13,300 feet on the Great Andes of the Equator. In many parts of the world there are land-crabs, but none of these live in the British Isles. This is referred to as follows in the 'Narrative of the Cruise of the *Challenger*.' In describing the visit to Ascension Island in the South Atlantic Ocean, the writer says:—

'Land-crabs swarm all over this barren and parched volcanic islet. They go down to the sea in the breeding season; they climb up to the top of Green Mountain, and the larger ones steal the young rabbits from their holes and devour them. It always seems strange to an English naturalist to see crabs walking about at their ease high up in the mountains, although the occurrence is common enough and not confined to the tropics. In Japan a crab is to be met with walking about on the mountain high roads far inland, at a height of several thousand feet, as much at home there as a beetle or a spider, and crabs of the same genus (*Thelphusa*) live inland on the borders of streams in Greece and Italy.'

France and Germany, as well as England, have reason to regret that the sunny south should have a monopoly of these land or river crabs, for they are delicate eating, and,

as writers of the sixteenth century inform us, they are much sought after for the tables of the Pope and cardinals.

From what has been said it will be seen that those who live inland enjoy no inconsiderable opportunities of observing crustaceans of various kinds, dead or living. The common and easily obtainable specimens will, as a rule, not be of the same species in different parts of the world, but they will often belong to the same or closely allied genera, and they will in any case afford similar facilities for study. The traveller would do well to remember that kinds easy to collect abroad or cheap to buy in foreign markets will probably be rare in his own country, and that therefore preserved specimens may be of future value to himself or acceptable to his friends at home.

Passing, however, from inland resources to those of the sea coast, the student will find an enormously greater and an almost bewildering variety of forms to engage his attention. Shore-crabs and hermit-crabs are often obtrusively conspicuous, as also are the operculate cirripedes with their sharp-edged shells coating large surfaces of rock. When a flat stone is lifted, not unfrequently a small specimen of the edible crab may be seen nestling in the mud. If the position is chosen in order to gratify the sense of smell, one would be inclined to adapt the words of the poet to the situation, and say that crabs want but little here below, but want that little strong. Clinging to the under-surface of a stone, a group of the broad-clawed *Porcellana*, the hairy porcelain crab, will often be found. They try to look as if they were not there, or they endeavour to slidder rapidly away. If one is seized by the claw, it will adhere as tenaciously as it can to the rock, and sometimes end the unequal contest by relinquishing the claw and running off without it. The lobster-like *Galathea*, under similar circumstances, is ready either to fight or run, a very Achilles for courage and speed. Specimens of the masked crab and of various spider crabs, and of others not commonly found alive upon the shore, are often to be met with upon it when an obliging gale of wind has thrown their carcases landward. The common

shrimp will sometimes attract attention by making an abrupt spring, after which it sinks softly into the moist sand, from which its imitative colouring makes it barely distinguishable. The stretches of sand on the shore, which to unobservant or inexperienced eyes might seem quite barren and deserted, are often teeming with crustacean life. The upper and driest zone will be riddled with the burrows of the sand-hopper. Lower down several other species of amphipods lie at a very small depth beneath the surface. Little biting carnivorous isopods are there, and occasionally others that are vegetarians. In some localities Cumacea can be found, but never very far from the waves, nor, when they are present, must it be expected that these animals will make a striking feature in the landscape. They are remarkably unobtrusive. Where rocks and rock-pools and various kinds of seaweed abound, and especially on sheltered coasts, a very large number of species of amphipods and isopods may be obtained, these being in most instances distinct from those found in the sand. Here is to be seen *Orchestia*, the shore-hopper, a near ally of the sand-hopper, *Talitrus*. Here are two of the marine species of *Gammarus*, and examples of their cousins *Melita* and *Mæra*, all of which, when on land, slip or wriggle along on their sides, and have in consequence been irreverently spoken of as 'scuds.' Many other forms, including some of the Caprellidæ or skeleton-shrimps, can be obtained by examining tufts of the finely branched seaweeds. At the lowest ebb of the spring tides, a day or two after new moon or full moon, species may be obtained which are rarely or never procurable higher up on the shore. Several of the isopods, however, may be taken, independently of the lowness of the tide, roaming among the coarser weeds, and mimicking in various ways the colours around them. The rocks which look least interesting, having no vegetation except the short black crumbling foliage of the *Lichina pygmæa*, supply the curious *Campecopea hirsuta*, an isopod easily to be confounded with the leaves of the tiny plant which shelters it. Found among cirripedes at low tide, however, it displays much brighter

colouring. Where wooden piles have been driven into the shore within tide-marks, the part which the water reaches is almost sure to be very soon attacked and taken possession of by two or three very distinct crustaceans, the two constant companions being the strange amphipod *Chelura terebrans*, with a name signifying the boring claw-tail, and a perhaps equally mischievous isopod, known as *Limnoria lignorum*, or the Gribble. With these is frequently associated one of the cheliferous isopods, the species *Tanais vittatus* in England, and *Tanais filum* in America, not concerned, it may be, in making the excavations, but only using them when made. Some Amphipoda and Isopoda shelter themselves in sponges and some in the branchial sacs of Ascidians.

Many free-living Copepoda may be obtained in rock-pools and by washing seaweeds, others from various Ascidians. Those parasitic Copepoda, which are commonly known as fish-lice, may often be procured by examining fishes when first brought to shore, and before they have been prepared for display on the fishmonger's board. New species of Crustacea have sometimes been discovered by the examination of the contents of a fish's stomach. This same repository will also occasionally yield good specimens of already known species.

The Cirripedes are all marine, most of them impatient even of brackish water, although one species, *Balănus improvīsus*, Darwin, will live contentedly for some time in water that is quite fresh. Several species are obtainable between tide-marks. Many attach themselves to the submerged sides of ships, and to other floating objects. Some make their home in sponges, corals, or shells, and in consequence specimens not sought for their own sake are frequently distributed by the commerce of which their dwelling-places are the more direct object.

For the Gigantostraca collectors in England must content themselves either with fossil or with imported species. In New England, the horseshoe crab, *Limulus polyphemus*, may be had at or just below low water.

By availing himself, then, of those Crustacea which

live on land or in shallow waters, or on the coast, and of those specimens which are brought to shore either as or in connection with articles of food, the student may obtain a thoroughly representative collection. Closely as all the easily accessible localities and resources have been already searched and examined, even from among them he will find it still possible to add new species to the long roll of those hitherto known. In many of the forms that are common and abundant, and that have long been familiar to science, he may, by diligent observation, find features of great interest that have heretofore escaped notice. One discovery he will almost certainly make, that the objects of his study do not deserve the epithets of contempt and disgust so freely lavished upon them by the ignorant. At every step he will be increasingly charmed by the striking characters which different species exhibit, by the delicate grace or the intricate mechanism of the separate parts, and by the marvellously varied adaptation of the different organisms to their diverse modes of life.

It is, however, in the waters of the ocean, from the surface down to the abyssal depths, that the vast majority of the Crustacea are to be found. Of the lower limits of the so-called bathymetrical distribution a good general idea may be formed from the results of the dredging and trawling carried on by the *Challenger*, during a voyage of nearly seventy thousand miles. Of the Brachyura indeed, only a single specimen of a single species was taken so low down as 1,875 fathoms. Mr. Miers, who named it *Ethusa* (*Ethusina*) *challengeri*, says: 'This is the greatest depth at which any Brachyurous crustacean was taken by the expedition, and also, I believe, the greatest hitherto recorded for any species of crab.' It was not, perhaps, to be expected that members of the highest order in the class would either need or condescend to penetrate into the very lowest regions, where light and heat and vegetation, not to speak of cheerful society, must at the best be very scanty and extremely scarce. The very genus *Ethusa*, with its sub-genus or neighbouring genus *Ethusina*, seems to apologise for frequenting levels beneath its

natural rank by including the forms which, as Mr. Miers observes, 'evince the greatest degree of degradation from the Brachyuran type.' It approaches in fact the group which till recently held a distinct position under the name of the Anomura. Of these Dr. Henderson observes that they occupy an intermediate position between the Macrura and the Brachyura, in regard to the limit of depth at which they are found, the more highly specialised forms being, like the Brachyura, found in shallow water and at moderate depths, whereas the more primitive macruran types extend to the abysses of the ocean. The single and singular specimen on which the species *Tylaspis anomala*, Henderson (see Plate VII.), was established, 'came from the greatest depth at which any anomurous crustacean was taken by the *Challenger*,' the depth in question being 2,375 fathoms. In the Macrura two genera, *Benthesicymus* and *Gennădas*, instituted by the late Mr. Spence Bate, descend to 3,050 fathoms, and have nowhere been found dwelling with less than 300 fathoms of water above them. It is not perhaps surprising that most of the specimens were brought up 'in a soft, pulpy, and collapsed condition,' for it is calculated that each perpendicular mile, that is, each 880 fathoms of water, exercises a pressure of a ton upon each square inch of an animal's surface. As long as the fluids within correspond with those outside the body, there is a state of comfort and efficiency, but when this equilibrium is suddenly destroyed, not only a crustacean but any other creature is likely to feel weak and discomposed.

Of the Schizopoda *Boreomysis obtusata*, Sars, was taken from a depth of 2,740 fathoms. On the other hand the Stomatopoda are content with far less profound explorations. Mr. W. K. Brooks reports that 'they are usually found in very shallow water, and with the exception of the specimen of *Squilla leptosquilla*, taken in the trawl by the *Challenger* in the Celebes Seas from a depth of 115 fathoms, and a specimen of *Lysiosquilla armata*, which Mr. S. I. Smith found in the stomach of a *Lopholatilus* from 120 fathoms, they are all from very moderate depths.' The *Challenger*

found a cumacean as low down as 2,050 fathoms, but some years earlier the Swedish Spitzbergen expedition obtained the appropriately named *Diastylis stygia* from the still lower deep of 2,600 fathoms. The Isopoda extend down to 2,740 fathoms, the Amphipoda possibly, but by no means certainly, to 2,500. Among the Entomostracans, a Phyllocarid species came from 2,550 fathoms, Ostracoda from 2,750, the strange copepod, *Pontostratiōtes abyssicŏla*, Brady, from 2,200, and a parasitic copepod, *Lernœa abyssicola*, was attached to a deep-sea fish brought by the trawl from 2,400 fathoms. Lastly, of the Cirripedes the great *Scalpellum regium* was dredged from a depth of 2,800 fathoms, the character of these animals giving more certainty than can be had with free-swimming Crustacea, that the specimens actually came from the depth assigned. In the use of trawls and dredges with open mouths, there is always a chance that specimens may be captured in the course of lowering or hauling in the instrument, instead of while it is being dragged along the ocean floor. By this means the record of the occurrence of specimens at astonishing depths is left open to some question. Yet on the whole there is fair reason to believe that most of the principal groups of Crustacea have representatives capable of supporting existence in regions of dense gloom, with a temperature icily cold, and under a column of water from two to three miles in height. Many species, indeed, of the Crustacea show a preference for a frigid climate, since where this condition prevails their swarms are far vaster and their bodies more bulky and solid than in waters less cold. These Polar forms, therefore, find no inconvenience, but the reverse, in the unheated temperature of the great depths, and though probably many of them could not possibly pass the tropical waters at or near the surface, far down there is a suitable water-way for them from one pole of the earth to the other.

It is rather the task of national expeditions than of any private collector to procure the exceptional forms which the remotest abysses of the sea have yielded and may be expected still from time to time to yield. There

are, however, unstinted riches of natural history which the ordinary student may obtain with comparatively simple means. By the use of the towing-net from a boat, especially after sunset in warm and calm weather, numerous larval forms of Crustacea are to be obtained, as well as adult forms of various orders. By dredging in a few fathoms, or even in a few feet, of water, species enough to occupy weeks and months of study may often readily be secured. For this work sheltered bays and inlets are favourable. When the dredge brings up apparently nothing but rugged pebbles and the worn shells of departed molluscs, these are not to be despised. Among them may be found the little crabs of the genus *Ebalia*, at the first glance perhaps rejected as if pebbles themselves. Rare Tanaids may come creeping out of the crevices of an old oyster shell. When sea-weeds are brought up in the dredge, they are not to be cast aside after a hasty examination as unproductive. They should be placed in a vessel of shallow water, and, though the crafty inhabitants lie close, they will eventually come forth. Sand and muddy ooze scraped from the bottom requires to be passed through a sieve or stirred about in a pailful of sea-water. After the stirring, and before the animals have time to regain the sand, the water must be poured off through a muslin bag which will retain the desired specimens. Some species, besides the edible ones, may be obtained by a sort of systematic fishing. A dead crab, for instance, let down in a lobster-pot, will attract one species or another according to the locality, the clan trooping to the feast in hundreds and thousands till they have consumed every particle of the dainty repast. The voracity, indeed, of some among the smaller Crustacea is such, and their numbers in some places so enormous, that they have been known in a single night to clear all the flesh off a dead seal. To such appetites almost any carrion is a sufficiently alluring bait. There is little need for surprise, under the circumstances, at the label on certain museum specimens, intimating that they were 'pulled off the head of a bear let down to the bottom to be cleaned.' Some of the Amphipoda attack the

head and other parts of the whale while the monster is still alive. On the other hand, whales and seals, and fishes large and small, swallow down the Crustacea in a truly wholesale manner, and so prevent these prodigiously prolific animals from producing a complete block in the cooler parts of the ocean. Independently of this interesting exchange of courtesies, which consists in alternately eating and being eaten, there is another kind of association between crustaceans and other animals, known as commensalism. In this the one creature lives, not at the expense of the other, but merely in companionship with it. Thus, on the common starfish there is found a thread-like minute species of the Caprellidæ. Though the starfish is very frequently to be met with on the shores, its companion *Pariambus typicus* (Kröyer)[1] is only seen on dredged specimens, so that apparently this tiny animal has the sense to disengage itself when its host is being driven into an unsuitable or dangerous position. Some of the Amphipoda Hyperidea are very frequently to be found upon jelly-fishes. One of the Gammaridea, *Isæa Montagui*, Milne-Edwards, appears never to have been found except upon the Spinous Spider Crab, *Maia squinado*, for clinging to which its feet, with their serrate widened extremities, are peculiarly adapted. A French zoologist, M. Edouard Chevreux, some five or six years ago, was searching this interesting crab for its already well-known commensal, when to his surprise, among the algæ and hydrozoa, with which the carapace is usually decked, he found not only the species he was in search of, but no less than twenty-two other species of Amphipoda into the bargain. *Maia squinado* is not found far to the northward. On the other hand a very distinct crab, but with some external resemblance to it, *Lithodes maia*, is not found far to the southward. Such facts of distribution are often of scientific importance. For instance, with regard to the comparatively narrow strip of land which separates North from South America, the geologist will desire to know how far the crustacean fauna of the sea on one side of the

[1] Formerly *Podalirius typicus*.

isthmus corresponds with that on the other. A close agreement would dispose him to consider that not so very long ago, in the large measurements of geological time, the Atlantic and Pacific may have been connected by a natural canal. From great divergence, such as is known to exist in the molluscan fauna, he would infer that the passage existed, if ever, only at a very remote period. In the large freshwater lakes of Southern Sweden, it was discovered some thirty years back, that a remarkable marine fauna existed, and the inference ingeniously drawn from a review of all the connected facts has been, that these sheets of water were at one time part of the sea, but have been cut off from it by the gradual elevation of the land. Upon this supposition, while the water was gradually losing its saltness, its marine inhabitants, with equal steps, were becoming habituated to a freshwater existence. But it must not be forgotten that the transfer of marine animals to brackish and fresh waters may take place by various modes of migration quite independently of geological changes. It has been noticed as curious, that shells, insects, and plants, inhabiting fresh water, are of comparatively few species, but those few very widely distributed. Mr. Belt ingeniously remarks that, in the oscillations of sea and land, the oceanic and continental domains, though shifting, are continuous, whereas every freshwater area is liable to be again and again completely overwhelmed. By this means the freshwater species of narrow range may be entirely destroyed, and only families of wide distribution will survive. The application of this theory to the Crustacea is worthy of study, but the facts which it is designed to explain do not embrace the whole of the globe. The Isopod *Asellus aquaticus* and the Amphipod *Gammarus pulex* are obvious instances of freshwater species with an enormous range. Yet from the fresh waters of the Malay archipelago the Asellidæ and Gammaridæ are said to be entirely wanting. On the other hand, Professor Max Weber has recently observed that, while Europe can show but seven species of freshwater decapods, the Indian archipelago can boast of more than eighty.

CHAPTER III

MAGNITUDE

In zoology, size attracts attention in comparison with two standards. Man contrasts the bulk of an animal either with the average in his own order or with that of the group to which the particular animal belongs. An elephant is a huge beast, not in competition with a whale, but with a human being. A hornet less than a man's little finger is a monster beside a house-fly or a gnat. As in all classes the majority of individuals conform pretty closely to the average magnitude, the mind becomes trained to regard the exceptional extremes with wonder, often not unmingled with admiration when the mass is not smaller but greater than common. Among the Crustacea there are forms, not indeed surpassing all others in diminutiveness, but at any rate so exceedingly small that the sharpest eyes could perhaps never have found out that they were crustaceans without the aid of the microscope. Here it is that the philosophical naturalist sometimes finds chief reason to marvel, in perceiving the whole machinery of life, enabling active locomotion, nutrition, and reproduction, with senses, a power of choice, and the capacity for feeling pleasure and pain, all packed away as neatly and conveniently as possible in so extraordinarily small a casket. For preliminary studies creatures of more considerable compass hold an obvious advantage, and with most observers it is rather the giants of an order than the dwarfs that are deemed especially remarkable and worthy of the notice which they are fitted readily to engage. Some of the old writers probably understood

that their readers would take more interest in a large crustacean than in a small one. For this reason, no doubt, Olaus Magnus declares that between the Orkneys and the Hebrides there lives a kind of lobster so large and strong that it can catch a swimmer in its claws and squeeze him to death. His picture, as will be seen, represents a bearded man as a mere plaything in the lobster's arms. The human race is avenged in the companion picture, where a lobster twelve feet long is itself being ruthlessly devoured by a 'rhinoceros whale.' Though these myths are many centuries old, they still have an amusing interest to the Anglo-Saxon from having been localised in British waters. It is, however, very extraordinary that at the beginning of the present century a travelled French naturalist of eminence should have accepted a statement little differing from that of Olaus. L. A. G. Bosc in 1802 published his 'Natural History of the Crustacea, containing a Description of them and their Manners,' in the Introduction to which he says:—

'It is related that on the coasts of the isles of America, where the crabs are in great profusion, they engage during the pairing season in desperate conflicts, which often result in the death of numerous individuals, and always in the loss of a great many of their limbs. It does not appear that the Crustacea of Europe have this custom; but their small numbers, and the perpetual hunting after them, do not permit so easy an observation of their habits, as in warm countries, where it is said that they are of a size so monstrous, that they attack men, and have eaten several, amongst others the famous sea captain Francis Drake (François Drack), who, although armed, could not avoid this fate.'[1]

This passage is still retained in the revision of 1830, edited by the well-informed Desmarest. The story appears to have been derived from De Paw's 'Recherches Philosophiques sur les Américains' (t. i. p. 245), a work which describes the death of Drake as follows:

[1] *Histoire Naturelle des Crustacés, contenant leur Description et leurs Mœurs*, p. 149.

'This navigator having landed on the Isle of Crabs in America, he was there immediately surrounded by these animals; although he was armed, although he made a stout resistance, he had to succumb. These monstrous crustaceans, the largest known in the world, cut in pieces with their claws his legs, his arms, and his head, and gnawed his carcase to the very bones.'[1] There are some elements of truth in this blood-curdling story. It is true that Drake died in the West Indies. It is true that he landed on Crab Island. It is true that he met with huge crabs. But he died on board his own ship of a sickness brought on by disappointment, and his body wrapped in a leaden shroud was buried in the sea. The Crab Island on which he once landed was in the Eastern not the Western Main, nor did he lose his life upon it. The landing was in the course of his successful voyage round the world, and it was not the crabs that ate Drake, but Drake and his people that ate the crabs, of which a single one, they afterwards said, was sufficient to make a meal for four men. That might well be, if the crabs at all resembled the giant crab of Australia, *Pseudocarcinus gigas* (Lamarck),[2] in which the carapace is said to be sometimes two feet in breadth, and in which one of the claws of the front pair attains a vast bulk. Such crabs as these may be thought to justify a statement in Linschotten's 'Voyage to Goa,' according to which, 'To the South of *Goa*, at a place called *St. Peter's Sand*, there are Crabs so great and numerous, that Men are forced to keep a good Watch to defend themselves, for if they get one in their Claws it costs him his life.'

No crustaceans, however, either extinct or extant, can compete in size and power with those fabled by Olaus and De Paw. In the far distant Silurian age the fossil genus *Pterygotus* among the Merostomata is supposed to afford the largest specimens of the whole crustacean class.

[1] *Nouvelle Biographie générale*, edited by Hoefer, t. 14, p. 737. 1855.

[2] An author's name appended in parentheses by custom signifies that he is responsible only for the species, and that this no longer stands in the genus to which he had assigned it.

The remains make it probable that some of them attained a length of six feet and a breadth at the widest part of the body of nearly two feet. The sculpture on the carapace, like conventional feathers drawn by some old Assyrian artist, is thought to have led the Scotch quarrymen to call these giant fossils by the quaint name of Seraphim.[1] Great as their size was, their organisation would have little fitted them to cope with an armed knight. Their nearest living allies belong to the genus *Limulus*, in which the eastern King Crab, *Limulus moluccanus*, attains a breadth of a foot by a length of two feet, although, to be sure, nearly one half of the length consists only of a great caudal spine. Among the Brachyura, Japan possesses a species which is certainly from one point of view a rival in size to the largest *Pterygotus*, and may almost seem to justify the old mythical narratives, for *Macrocheira Kämpferi*, de Haan, as a specimen in the British Museum shows, can span eight feet, and it is said that sometimes even eleven feet are within the compass of the outstretched arms of the male. But portentous as we must allow these dimensions to be, the animal is after all only a spider crab, with comparatively weak and spindly legs, and a carapace which seldom if ever exceeds twelve inches in either length or breadth.

The fossil Trilobites, which compose the third order of the Gigantostraca, include indeed many species of inconsiderable size, but they are also represented by forms such as *Asaphus tyrannus*, Murchison, about a foot long, and others in the genus *Paradoxides*, measuring twenty-one inches.

Among the spiny lobsters or crawfish, a New Zealand species, *Palinurus tumidus*, has recently been described by Mr. T. W. Kirk as measuring twenty-four inches from the tip of the beak to the end of the tail, and as having the carapace very much swollen, and measuring $21\frac{1}{2}$ inches in circumference. The European *Palinurus vulgaris* attains a length of 18 inches, also without including the antennae,

[1] H. Woodward, *Transactions of the Palaeontographical Society*, 1866, p. 42.

which are sometimes considerably longer than the animal's body. The common lobster, though less bulky in the trunk and with more slender antennæ, attains an equal length, or by inclusion of its long and powerful claws might claim in this respect far to exceed the weak-limbed *Palinurus*. There is an Australian crayfish, *Astacopsis serratus* (Shaw), from ten to twenty inches long, and weighing some pounds, which makes a fine show when compared with the much more modest dimensions of the English crayfish. In the same way *Leander serratus* (Pennant), the common prawn of British markets, is humbled by contrast with *Palæmon carcinus*, the river prawn of the West Indies and Guatemala, of Surinam and the Ganges, with its lobster-like size of twelve inches long. *Palæmon lar*, from the Pacific Islands and India, exaggerates one of the characteristics of the genus to which it belongs, inasmuch as a male specimen five inches in length will have the second pair of legs nearly eight inches long—much longer, therefore, than the body which carries them. The Hermit Crabs appear to attain their maximum at about eight inches, a length not inconsiderable, seeing that it has to be accommodated to the vacant shell of a univalve mollusc. One, however, of their near kindred, *Lithodes camschatica* (Tilesius), has sometimes a span of four feet. This makes its hermitage not in the shell of a mollusc, but in some cranny of the rocks. From this fastness it takes vengeance on the crab-eating octopus, and is itself so firmly lodged that it cannot easily be dragged out, except in fragments. Of shrimps, *Pasiphaea princeps* (S. I. Smith), dredged by the *Albatross* in 1883, may be accepted as the leader, seeing that it is not only far larger than any of its own genus hitherto known, but by its length of more than eight inches and a half, it exceeds all examples of kindred genera.

Among the Schizopoda the more familiar species are quite the reverse of bulky. A specimen of *Gnathophausia ingens* (Dohrn), measuring from the tip of the rostrum to the extremity of the telson or tail 157 millimètres, or $6\frac{1}{4}$ inches, is spoken of as possessing 'a truly gigantic size

for a Schizopod.' It is also said that 'this form ranks, therefore, as the largest by far of all hitherto known Schizopods,' although in truth an allied species in the same genus, *Gnathophausia gigas*, v. Willemoes Suhm, obtained by the *Challenger* from a depth of 2,200 fathoms, measures 142 mm., or $5\frac{2}{3}$ inches. Both of these species, with one or two others in the same genus, such as *Gnathophausia Goliath*, A. Milne-Edwards, far surpass most of those in the sub-order, the length usually ranging from half an inch to two inches.

Of the Stomatopoda, some are no more than three-quarters of an inch in length, but of the species *Lysiosquilla maculata* (Fabricius), a male specimen, presented to the naturalists of the *Challenger* by the King of Amboina, fell short only by three-sixteenths of an inch of measuring a whole foot.

The Cumacea are a feeble folk. In some species the slender frame, with trunk and tail and tail appendages all told, does not exceed, or even equal, a twelfth of an inch. Only the arctic *Diastylis Goodsiri* (Bell), occasionally yields a Goliath of an inch and two-fifths. In the Isopoda there is a far greater range of size. Within a single genus, *Eurycōpe mutica*, Sars, which measures about one millimètre and a third, is contrasted with *Eurycope gigantēa*, Sars, which reaches 33 millimètres, or about an inch and a third. *Anilocra gigantea* (Herklots), measuring three inches and a third, would seem a veritable monster in this sub-order, were it not far surpassed by the extremely exceptional *Bathynŏmus giganteus* of Alphonse Milne-Edwards, which is nine inches long by four inches broad.[1] This prize was fished up by the United States Survey steamer *Blake*, under the supervision of Alex. Agassiz, from a depth of 955 fathoms, in the region of the Gulf Stream, to the north-east of the bank of Yucatan to the north of the Tortugas. Among the Amphipoda, none yet discovered reach more than about half the dimensions of this great Isopod. At the other end of the scale

[1] *Il mesure, en effet, près de* 0^m, 23 de long sur 0^m 10 de large.

there are Gammarids, Hyperids, and Caprellids, of microscopic proportions, but for colossal species each Amphipod division must be content to compare its members one with another, rather than with the outside world. In the threadlike Caprellidea, some of which might be regarded as creatures of only one dimension, the *Challenger* species, *Dodecas elongata*, by help of its antennæ and hind legs, can stretch over a space of three inches. In the Hyperidea, *Rhabdosōma armatum* [1] is not quite so thin, but its length is greater, since the tip of its rostrum is sometimes nearly five inches distant from the extremity of its caudal appendages. In the same section the remarkable genus *Cystisoma* has species which combine a length of four or five inches with the respectable breadth and depth of an inch in the amplest part of the head. The chief boast of the Gammaridea is *Eurythĕnes gryllus* (Lichtenstein in Mandt). The first specimen observed of this full-bodied animal was three inches long and two inches and a quarter round the waist. It was disgorged in the far north by a wounded arctic petrel. Twenty-seven years later it again attracted scientific attention, singularly enough the specimen this time coming from the far south, for it was taken from the stomach of a fish caught off Cape Horn. Its body was nine centimètres long and three deep—in other words, more than three and a half inches in length and more than one inch in depth. In recent years the apparent anomaly of its occurrence both in arctic and sub-antarctic waters has been explained by evidence that it can make itself at home in the intervening expanse, since in 1883 the American steamer *Albatross* captured a specimen over four and a half inches long, in deep water off the middle Atlantic coast of the United States. This must be regarded as the bulkiest of the Amphipoda yet known.

The Entomostracans make their position in the world's

[1] It is doubtful whether the change of this name to *Xiphocephalus armatus*, as proposed by Dr. Bovallius, can be justified, since the name *Xyphicéphale* was only given by Eydoux and Souleyet on Guérin's authority in trivial not in scientific form, an ill-spelt French name for a genus rather hinted at than established or defined, the name moreover not being definitely given but only contingently suggested.

economy remarkable far more by their incalculable numbers than by their individual measurements. In regard to the Phyllocarida, Dr. Packard remarks that the palæozoic species were gigantic in size, some being about a foot or more in length, while our recent *Nebalia* is less than an inch. The new species, *Nebaliopsis typica*, Sars, however, may extend the magnitude of modern examples to an inch and three-fifths. The Phyllopoda can exhibit *Estheria californica*, Packard, in a shell 16 millimètres long, ten broad, and four thick, and *Apus Newberryi*, Packard, with the carapace, the abdomen behind the carapace, and the slender caudal appendages, each an inch long. But the amplitude more usual in the sub-class may be estimated by the respect paid to such a species as *Bythotrephes crassicauda*, Lilljeborg, 5 mm. long, one of the Cladocera. This is a colossal species of a fifth of an inch! Among the Ostracoda, *Crossophŏrus imperator*, G. S. Brady, is one third of an inch long, and with good reason Dr. Brady cannot restrain his admiration of 'this noble species, certainly the largest of the known Cypridinidæ.'

In the Thyrostraca or Cirripedia a total length of two or three inches will deserve and earn the lordly epithets of *eximium*, *regium*, and *gigas*, but the Patagonian *Balanus psittacus* (Molina), which grows rapidly and is 'universally esteemed as a delicious article of food,' attains six inches in length by three and a half in diameter, and a specimen has been found no less than nine inches in length, though only two and a half in diameter. Of the pedunculate species, *Lepas anatifera*, the common Goose Barnacle, can grow a stalk more than a foot long. Darwin says: 'The largest specimen which I have seen had a capitulum two inches in length; the longest, including the peduncle, was sixteen inches.'

CHAPTER IV

ON STRUCTURE

THE body of a crustacean is externally divided into a theoretically constant number of segments and paired appendages. In the Malacostraca, it generally exhibits a more or less clear partition into head, trunk, and tail, or, as these parts are sometimes called, cephalon, thorax, and abdomen. There is indeed a rather bewildering supply of alternative names, which it is needless for the moment to discuss. The objections to the use of the word *thorax* have been already mentioned. Throughout the sub-class, however, the head is found to be united to some portion of the trunk, and to denote this variable combination the convenient word *cephalo-thorax* is very frequently employed for the region covered by the carapace. It is a matter of opinion whether the full number of true segments should be reckoned as twenty or twenty-one, since that which is called the telson, and which is regarded by many authors as the terminal segment, is considered by others not to be a true twenty-first segment, but a median outgrowth of the twentieth. Scarcely ever can the whole number be distinguished in one and the same animal. As the Entomostraca always have more or fewer than the theoretical number, there is some need for the eye of faith to include them in the reckoning. The foundation of the integument which forms the external skeleton of a crustacean is a tolerably flexible substance called *chitin*. This is hardened and consolidated by being impregnated with calcareous salts, and the absence of these leaves the skin the requisite flexibility for acting as a joint between one hardened part

and another. But the joints themselves are sometimes consolidated, and then it is said that two or more segments have coalesced. This is not a merely arbitrary statement, for, comparing the Malacostraca one with another, the conclusion cannot be avoided that a single segment is limited to a single pair of appendages. Segments which are not independent in one of the families will be found well articulated in another, and those which can least boast of freedom nevertheless frequently point to an original independence by some suture or groove, if not by the actual separateness of the segmental ring in some small part of its circuit.

No rigid definition is possible of a head. It is bound to contain the animal's mouth, and may be expected to include the brain and organs of the senses of sight and hearing, smell and taste. In birds and in mammals its limits are conveniently defined by the neck, but in the Crustacea there is no such obvious constriction separating it from the trunk. Consequently its true limits here are still a subject of dispute, which cannot be settled offhand by an appeal to the cervical groove, even when that is conspicuous. By various authorities the first five, six, or seven segments have been assigned to the head, and in the higher crustacea it might not unreasonably be regarded as comprehending the first nine. This will be understood from a consideration of the form and functions assumed by the several appendages, only those in front of the mouth-opening or directly contiguous to it being accepted without dispute as cephalic, although others in variable number are concerned in the operation of feeding.

Glancing along the whole line of limbs, as the outgrowths from the segments have some right to be called, twenty pairs in number, we find them successively devoted to seeing, feeling and otherwise perceiving, feeding and presumably tasting, grasping and striking, walking and digging, swimming and leaping. But although the order in which they act may thus be generally stated, there is not unfrequently a transfer of function from one part of the line to another. The feelers may be employed to assist

in swimming or climbing or clasping. The mouth-organs of one group are the grasping weapons of another. The walking legs of one set are elsewhere adapted for swimming. There are also other functions conjugal or maternal in which the swimming legs or the walking legs may take part, while the breathing apparatus, simple or complicated, may be connected with the mouth-organs or limbs of the trunk or both, or else with the swimming organs of the tail-part, commonly called the pleon. These and other curious modifications are largely made use of in classifying the Crustacea, and to understand the unavoidable intricacies of any system of arrangement, the outgrowth of each segment should be studied, in some form the less abnormal the better.

1. The first segment is known as the ocular or ophthalmic. This is clearly articulated in the Squillidæ, but only occasionally in other groups, as in the macruran *Plesionīka uniproducta*, Sp. Bate. Its individuality is in no way indicated in the sessile-eyed Crustacea, in some of which the eyes pretty well cover the whole dorsal surface of the head. In the Brachyura and Macrura its original independence can often be traced, but it is in these chiefly attested by the pair of movable appendages which it almost invariably carries. Now, just as it is thought that all the segments represent a common original type variously modified, a similar view is applied to all the appendages that arise from the segments.

The resemblance, in fact, is often very obvious between the antennæ and the swimming feet; between the laminar maxillæ near the mouth and the opercular and breathing plates in the tail; between the maxillipeds, which are instruments of nutrition, and the ambulatory legs of the trunk; so that a connection, at first sight very improbable, is satisfactorily established between them all, when the comparison has been sufficiently extended. Yet it demands some exercise of faith on the part of a novice to accept the declaration that this homology holds between the claw of a lobster and its eye. No two parts of an animal could well be more unlike in appearance and func-

tion. It is unusual to think of a creature's eye as one of its limbs, for only by a figure of speech do we describe a person as *grasping* the whole situation at a glance. Nevertheless, there are very few inclined to dispute that the eyes of the Podophthalma have really been developed upon appendages by nature equivalent to the rest of the series. Any one acquainted only with the extremely short-stalked eyes of some of the crabs might be excused for thinking this view extravagant, but its improbability is lessened when we observe the long-stalked eyes of the Angular Crab, *Gonoplax rhomboides* (Linn.), or those of the macruran *Leucifer Reynaudii*, Milne-Edwards, or those, again, of *Eretmocăris longicaulis* (see Plate XIII.), a shrimp in which the eye is projected on a support actually longer than the animal. Moreover, the ocular appendage, besides being articulated to the head, is itself composed of two or three articulations. In the fast-running *Ocypŏde cursor* (Linn.), the peduncle is extended beyond the cornea of the eye, and terminates like an antenna in a pencil of long hairs. There is one instance on record in which the eye of a kind of lobster, *Panulirus penicillatus* (Olivier), has been observed to develop a jointed antenna-like lash, while the companion eye remained normal. This evidence is parallel to that on which a botanist infers that the petals of a flower are by origin modified leaves when he sees them occasionally assuming the form of the unmodified leaf.

2. The second segment carries the first pair of antennæ, sometimes called the inner or upper, or, without epithet, the antennules. In the Malacostraca normally these appendages consist each of a three-jointed peduncle and two flagella or lashes, composed of many joints or few, the inner or secondary flagellum being not unfrequently absent altogether or rudimentary. In some instances, and in the Amphipoda Caprellidea and in the Entomostracan Copepoda not as an exception but as the rule, the first antennæ are larger than the second, from which it results that the diminutive name *antennules* is rather convenient than appropriate. The superior size, however, is no indication of higher rank, but rather the

reverse. These organs are sometimes most dwindled in families which can claim a decided precedence over others in which these appendages are well developed. Thus they are short in the crabs, but long in the lobsters and shrimps, and short in the normal Isopods, but long or large as a rule in the Amphipoda, and within the Amphipoda they are short in the Orchestidæ, a family that claims superiority by its tendency to terrestrial habits.

Those who have made themselves acquainted with Professor Huxley's volume, 'The Crayfish,' in the International Scientific Series, will be aware that in describing a crustacean appendage he names the first two joints the *protopodite*, which bears at its extremity on the inner side the *endopodite*, and on the outer side the *exopodite*. For these terms the shortened forms *exopod* and *endopod* will here be preferred—exopod for exopodite, endopod for endopodite and protopodite combined—and peduncle will be used for a variable number of basal joints. In the first antennæ the peduncle consists, as already stated, of three joints, and by this circumstance the rule which widely prevails elsewhere that the so-called protopodite ends with the second joint of an appendage is broken without any obvious cause. Moreover, that which by its function and in general by its superior size appears to be the main branch is here the outer one, and not as usual the inner. It is conceivable that the exopod is wanting, that the main branch or principal flagellum is the true endopod, and that the secondary flagellum is an independent outgrowth. For the reasons mentioned, and some others, Dr. J. E. V. Boas considers that the first antennæ are not homologous with the following limbs, but that both they and the stalked eyes ought to be regarded as limb-*like* sense organs. That besides being organs of touch, they are frequently organs of other senses, seems to be beyond doubt. In the Macrura at large the first joint contains an auditory apparatus. Sometimes the cavity is provided with a well-formed otolith or ear-stone. In the lobster and crayfish, Mr. Spence Bate says, 'the perforation is long, narrow, and slit-like, the aperture being scarcely

appreciable, and opens into a calcified chamber, more or less filled with particles of sand, which are voluntarily placed in position by the animal soon after casting its exuvium.' But while the higher Podophthalma have the organ of hearing thus placed, there are some—the Mysidæ—which, extraordinary to relate, carry it in the tail (see Plate XIII.). In some of the Amphipoda otoliths have been detected in connection with the brain, not in, but behind the antennæ. In general, the antennæ are furnished with delicate plumose hairs, the vibrations of which assist in the conveyance of sound to the auditory nerves. Similar hairs in the Mysidæ are connected with the caudal otoliths. The principal flagellum of the upper antennæ is frequently furnished with a number of smooth setæ or filaments, which were at one time described as auditory cilia, though there was nothing to support this guess at their function, and though the term *cilium* was inappropriate to the shape of these rod-like membranous filaments. It was noticed by various naturalists of eminence that the setæ of this form were much more abundant in the adult males than in the young males or in the females. Leydig supposed them to be not auditory but olfactory organs, and Fritz Müller independently came to the same conclusion, adducing in support of it their stronger development in the males, as in other cases male animals are guided by the scent in pursuit of the females. It can scarcely be said that their olfactory function is as yet absolutely proved, but they are evidently not well placed to serve the sense of taste, and for the senses of sight, hearing, and touch, there are other organs much better adapted, so that these glassy filaments, to be sensory organs at all, are in a manner forced back upon the sense of smell.

The secondary or inner flagellum, according to Dr. Boas, is wanting in all genuine Nauplii—that is, in the earliest larval stage of the crustacean. Its after development conforms to no known rule, since in some species it is not found at all, in others it is only rudimentary, whereas, on the other hand, among the Macrura it is not unfrequently much longer than the outer flagellum. Mr.

Spence Bate suggests that its function may consist in protecting and keeping clean the mass of cilia and filaments attached to the outer branch. In some genera of the Macrura, for example *Palæmon* and *Alpheus*, the principal flagellum divides at some distance from its base into two branches. In the Squillidæ, also, there are three flagella.

3. The third segment carries the outer, under, or second antennæ, sometimes called simply the antennæ in distinction from 'antennules.' They are rarely absent, as in the females of some Amphipoda. More often they are strongly developed, in some instances exceeding in length all the rest of the animal which carries them, the joints of the flagellum or lash being then very numerous. In the Malacostraca the peduncular portion embraces the first five joints. The exopod, when developed, as it generally is in the Macrura, very commonly has the form of a thin plate known as the antennal scale, in Latin *squama*, while those who love long words are privileged to call it the scaphocerite. When laterally extended this broad scale must assist in keeping the animal upright in the water, a position which would otherwise with difficulty be maintained by long-bodied forms. In some Crustacea, the scale, though present, has not a laminar character, and it is then spoken of as the acicle. The first, or basal joint of the peduncle, is not unfrequently soldered to the wall of the head, and very often carries a tubercle in connection with the 'green gland,' of which the function is supposed to be renal, though it has not been with certainty determined. That this tubercle is of some importance may be inferred from the fact that in some cases where the antenna itself is obsolete the tubercle persists.

It is not a little singular that up to thirty years ago or later, many naturalists of eminence regarded this tubercle as connected with the auditory apparatus, which they assigned to the base not of the first but of the second antennæ. Milne-Edwards in 1834 refers to the researches of M. Savart, who had discovered that the stretching of a fine elastic membrane over an opening was one of the circumstances best adapted to promote the appreciation of

sound. Just such a membrane Milne-Edwards considers to exist at the base of the antennæ now under discussion, and in some of the Brachyura he and his colleague Audouin had investigated an inner apparatus capable of increasing the tension of the disk at the will of the animal, an arrangement which he compares with that of the auditory ossicles and the tympanic membrane of the human ear. It is only with reluctance that this description of a natural telephone can be relinquished. In some species, such as the common rock lobster, *Palinurus vulgaris*, there is a stridulating apparatus in the basal joints of the second antennæ, and it is obviously unlikely that a sound-producing organ should have been developed in an animal's ear.

4. The fourth or mandibular segment is of great importance, since from this, or from it in conjunction with the preceding segment, the carapace is developed. Its appendages also, the mandibles, yield in value to very few of the other organs. In form they vary extremely, but are for the most part of powerful structure. Their edges meet over the mouth-opening between the upper lip and the lower. The trunk of the mandible is frequently massive, with a projecting, finely denticulate, grinding surface called the molar tubercle, and a thick or thin dentate cutting edge, often having also a variety of spines between these two processes. It is not seldom surmounted by a narrow piece, commonly called its palp, which never in the Malacostraca consists of more than three joints. Very rarely, and only among the Entomostraca, one of the joints of the palp has an outgrowth supposed to represent the exopod. Since theoretically the exopod always arises from the second joint of an appendage, it is argued that the trunk of the mandible must represent the first joint. But to this it may be answered that the exceptional outgrowth just mentioned is perhaps not an exopod, and that at any rate in the first antennæ there is a similar outgrowth from the third joint. In *Euchæta glacialis*, Hansen, and some other Entomostraca, the mandibular palp divides into two branches from its second joint. Seeing that the first joint of a crustacean appendage is very rarely of large

size, it is a question whether the trunk of the mandible may not represent a coalescence of the first and second joints, or even of the first three or four joints. The latter supposition would explain the circumstance above noticed that its 'palp' or terminal portion in the Malacostraca never exceeds the number of three joints, though it may be reduced to two or one, or may vanish altogether (see Plates XII., XV., XIX.). On the inner side of the mandible there is sometimes, adjoining the cutting edge, a plate which more or less closely imitates that edge in its character. It has now been made probable that this secondary plate is a modification of one of the spines above noticed, and, as if to show the plasticity of nature, sometimes the series of spines mimic the secondary plate.

The upper and lower lip seem best to be regarded as modifications of the integument, where it is turned in to form the alimentary canal, commencing with the œsophagus or gullet.

An American lady, Miss J. M. Arms, however, in her very clever little work on Crustacea, in Alpheus Hyatt's 'Guides for Science-teaching,' maintains that the leaves of the lower lip 'are independent outgrowths or buds from the integument, as much as any other pair of appendages; and the fact that the parts of the segment to which they must have belonged have disappeared, or cannot be readily found, is,' in her opinion, 'an argument of doubtful weight.'

The theory that all the appendages of a crustacean are either legs or modified legs will strike a casual observer as rather strained in its application to the mandibles. That a crab should adapt the basal joints of a pair of limbs for masticating its food may seem as unlikely and absurd as that a man should have teeth on his elbows, and should draw them up in front of his lips for the purpose of biting and chewing whatever he wished to put into his mouth. To prevent all cavilling, however, on this point of the theory, the King Crab, *Limulus*, is so obliging as to ignore the ordinary mouth organs, and to use the bases of its actual walking legs as mandibles.

5. Close up to the lower lip, and as little leg-like as any of the appendages, are placed the first maxillæ. They are almost always thin and foliaceous, with few joints, and those few not easy to distinguish. The pattern is extremely variable. The functions are obscure. There are sometimes strong fringing spines which may assist in dividing the food. There are plumose hairs, some of which may be connected with the sense of taste. The position of these organs has also suggested that they may 'be useful in preventing the escape of food from the lateral angles of the mouth.' It is with these that some authors close the number of true cephalic appendages. Of those which follow some are frequently, but none with the same constancy, developed into mouth-organs.

6. The second maxillæ, when present, have generally the same thin flattened character as the first, but their structure is often more complicated. Among other peculiarities they have in some of the higher groups a membranous expansion or large lamina on the outer side, frequently termed the flabellum or fan, and compared by Milne-Edwards to a ventilating register (see Plate XI.). This species of valve is in constant and rapid vibration, in most cases forcing the water which has aerated the gills to pass out in front, so that a new supply may be introduced from behind; but in some crabs (as *Dorippe*, *Ranina*, *Leucosia*) according to de Haan the water is introduced in front, and passes out behind. Huxley supposes that this valve may represent the epipod, that is to say, the branch which is given off by the first joint of an appendage, or else that it may be a combination of the epipod of the first joint with the exopod of the second.[1] Professor Sars regards it as the exopod,[2] while Dr. Hansen considers that it springs from the third joint.[3] In those Crustacea which have the branchiæ either not enclosed in a chamber or in one remote from the head, this part of the maxilla is either absent or rudimentary (see Plates XVI., XIX.).

[1] *The Crayfish*, p. 170. (The scaphognathite.)

[2] *The Norwegian North Atlantic Expedition Crustacea*, p. 21.

[3] *Oversigt over de paa Dijmphna-Togtet indsamlede Krebsdyr*, p. 193 note, and p. 252.

7. The appendages of the seventh segment are distinguished from the two preceding pairs by the name maxillipeds, meaning maxillary feet or jaw-feet, because they often conspicuously combine the function of a mouth-organ with the general appearance of a crustacean leg. This is very much the case in the Amphipoda, where they conclude the series of cephalic appendages, having here something of the opercular function which they exercise still more conspicuously in the Isopoda. In the Copepoda, which are content with one pair of maxillæ, there are two pairs of 'foot-jaws,' in regard to which the singular discovery has been made that they belong to a single segment, and yet do not violate the rule that a single segment is limited to a single pair of appendages. By tracing the process of development Dr. Claus made it clear that they were in fact the exopods and endopods of a single pair of limbs, which had separated so as to wear the appearance of two distinct pairs, which is much as if the radius and ulna in the human arm were to become independent and produce a four-handed man.

In the higher Crustacea these appendages, without being divided, are only the first of a series of three pairs of maxillipeds. Their forms vary exceedingly in the different groups. Sometimes the endopod is seven-jointed like an ordinary limb, at others the terminal part is reduced to insignificance. Often the epipod and exopod are important both in size and function.

8. In regard to the eighth segment, a difficulty arises as to how the appendages should best be designated. In some groups, such as the Amphipoda and Isopoda, they belong not only in theory but in fact to the trunk, and they have in these groups been called gnathopods, a word which, like maxillipeds, means jaw feet, and which was chosen to indicate that they grasped the food in a jaw-like manner. But in the higher Crustacea these appendages practically belong to the mouth and not to the trunk, their general appearance and functions allying them closely to the preceding pair. Under these circumstances it seems best to call them the second maxillipeds. For,

though it has been strongly urged that one and the same term ought to be applied to homologous parts throughout the whole crustacean class, either nature has opposed the rigid application of such a system, or the wit of man has not yet been able to devise appropriate terms.

It may here be mentioned that the full number of joints for a malacostracan trunk-leg is seven. With a view to uniformity of nomenclature, the afflicted naturalist has for many years had to deal with these seven under the following names:—Coxa, basis, ischium, merus, carpus, propodus, dactylus, which respectively signify hip, foot, socket of thigh joint, thigh joint, wrist, forefoot, and finger or toe. Originally the names were longer, all being podites, from coxopodite to dactylopodite, to the use of which the philosophic French still adhere, though the time-saving Anglo-Saxon has for the most part rejected them. Among other difficulties in this terminology under either form, it has to be remembered that the basis is the second, not the basal joint of the limb. The more reasonable plan is now being widely followed of naming these joints simply according to their numerical order, the coxa being called the first joint, and the dactylus the seventh. But the older names have still to be borne in mind by those who study the older literature. Even the numbers are attended by a very unfortunate element of confusion. The late Axel Boeck, when introducing the use of numbered joints, was studying the Amphipoda, in which the first joint of a leg is seldom, if ever, free. Taking into account, therefore, only the six free joints, he called the second joint the first, and made the finger the sixth, instead of seventh. In treating separately of the Amphipoda or Isopoda, many naturalists have followed Boeck's usage as reasonable and convenient. But when other Crustacea are considered in which an appendage has the first joint or perhaps all the seven joints free, they must be numbered from one to seven, and whenever a comparison is needed between the limbs of the Edriophthalma and those in other groups, two different systems of numbering the joints cannot fail to be highly embarrassing. It must

further be noticed that there are Crustacea in which one or other of the joints, most often the fifth, is itself multi-articulate, thus adding to the normal number, which on the other hand is still more frequently diminished by coalescence, absorption, or complete failure of development, affecting various parts of the limb.

9. The ninth segment carries a very important and, at the same time, very variable pair of appendages, which, as the third maxillipeds, have in the higher Crustacea the same kind of opercular character that has been noticed as pertaining to the appendages of the seventh segment in some of the lower groups of the Malacostraca. In his celebrated and valuable work on the Crustacea of Japan, de Haan made great use of these third maxillipeds for classifying the Malacostracan group in respect to families and genera. The various joints of the endopod by their shapes, relative size, number, and mode of articulation one with another, have yielded a multitude of characters. In the Amphipoda, where the appendages of the ninth segment are not mouth-organs, but constitute the second gnathopods, they are commonly the most powerful limbs of the trunk, being, no doubt in general, the animal's most efficient weapons for holding its prey. In the Isopoda, on the other hand, they are to be called gnathopods only by courtesy, being in general little distinguishable from the following pair of limbs.

10, 11, 12, 13, 14. The appendages of the five following segments have been and may sometimes conveniently be called peræopods, which means walking-feet. Among the Amphipods and Isopods they are usually adapted for walking, and in those groups the trunk, to which they are attached, is often called the peræon, intended to signify the ambulatory part. Among the crabs and lobsters, and various other crustaceans, however, the first of these pairs is by no means adapted for walking, but ends in large claws or nippers, on account of which they are known as the chelipeds, and Mr. J. E. Ives proposes to call the four following pairs cruripeds, which means leg-feet, while Dr. A. S. Packard, unaware of what was intended by

peræon, has proposed to substitute for it 'bænosome,' a word of precisely the same sense. The epithets *chelate* and *sub-chelate* are of constant occurrence in descriptions of Crustacea. A limb is chelate when it has joints that will act together like a pair of tongs. Generally this character is produced by the hingeing of the seventh joint a considerable way down on the side of the sixth. When the seventh joint or finger can be folded back upon the sixth, although the latter is not produced into any thumb-like process to oppose it, the limb is then said to be sub-chelate, the claw being in that case partial, though often extremely efficient. The possession of chelæ is not confined to the first pair of so-called peræopods, although it is seldom elsewhere that they attain a monstrous development. They may occur on any of the pairs, and on several in the same animal. In connection both with the maxillipeds and the peræopods there are developed in great variety of form the branchiæ or gills, also the plates of the marsupium, wherein, in some groups, the eggs are retained for a time after their discharge from the ovaries; and again, in some groups, the exopods are developed as swimming organs. The vulvæ, or uterine openings of the female, belong to the sternal, that is the ventral, side of the twelfth segment, while the genital openings of the male occupy a similar position in the fourteenth segment. In those Crustacea which have the basal joints of each pair of legs brought close together, the openings in question have been transferred from the wall of the trunk to the first joint in each of the last pair of legs in the male, and of the antepenultimate pair in the female.

15, 16, 17, 18, 19, 20. The remaining segments belong to the tail or caudal portion of the animal, which has been termed the pleon or swimming-part, a convenient and often a very appropriate name, although on the other hand there are plenty of crustaceans which do not and cannot use the pleon to swim with. The first five of these segments frequently have appendages that are really natatory and may properly be called pleopods, swimming-feet. But some or all may be wanting, or rudimentary,

or devoted to other purposes. They may be partially or entirely branchial. Among the Stalk-eyed Crustacea they are often used in the female for retaining the eggs during an early period of development or hatching. In the Amphipoda the fourth and fifth pairs are more or less adapted for springing, and bear the name of uropods, or tail-feet. This name is also given to the appendages of the twentieth segment whenever they are present. These are prominent features in the Cumacea and most other Edriophthalma, and in the Macrura they combine with the telson to form the powerful tail-fan, for which Mr. Spence Bate has proposed the Greek name *rhipidura* (see Plate X.). In the Copepoda there is a 'caudal furca,' homologous with the caudal rami in the Nebaliidæ, which must be distinguished from the terminal uropods of the higher Crustacea, as 'being not true limbs, but more properly representing a bipartite terminal segment.'[1]

21. The telson is extremely variable in form and relative size, and sometimes by coalescence with the preceding segment shows little trace of independent existence. The intestinal canal opens on its under side. It is sometimes deeply cleft, as though the two terga, or dorsal plates, of a body-ring had come apart. To prove its claim to be regarded as a segment, the most effective argument would be to show that it sometimes carries appendages after the fashion of all the other segments. Bell, in the 'British Stalk-eyed Crustacea,' says that he has frequently observed appendages to the telson of the common prawn, *Leander serratus* (Pennant), 'in the form of extremely minute points attached to the very extremity of the segment, and moveable.' Spence Bate says, 'In some genera, or even families, the telson is posteriorly rounded, as in the Astacidæ; in others it is anteriorly hard and calcareous, and posteriorly soft and membranous, as in the Synaxidea, a circumstance that is suggestive of a distinct relationship of the two parts, the anterior which carries the anus belonging to the normal somite,

[1] Sars. *Report on the Phyllocarida* collected by H.M.S. *Challenger*, p. 35.

while the posterior portion represents its appendages. This idea is still more strongly suggested in the genus *Cheiroplatea*, where the separation of the posterior from the anterior division is clearly defined by a distinct membranous articulation, and the posterior portion is divided into two lateral lobes.'[1] The older genus *Porcellana* is even more to the purpose than *Cheiroplatea*, and Miss J. M. Arms, in the Manual before referred to, considers that it settles the question. Comparing a species of it with the lobster, 'This curious little crab,' she says, 'possesses a telson with an unmistakable pair of appendages attached to it, proving that this part is really a ring whose appendages are wanting in the lobster.' It must, however, be remarked that neither in the Porcellanidæ nor in the Galatheidæ do these apparent appendages of the telson ever become freely articulated with it, and as they are the last to put in any appearance at all, and then only in a late stage of the animal's development, it remains a question whether they may not be dividing lines of the telson rather than appendages arising from it.

In the internal organs of crustaceans the differences are as great as in the external. One writer has even undertaken to classify the Brachyura according to the structure of their stomachs. Unless this part of the organism were tolerably complicated, it will be easily understood that it would not afford sufficient variations for such a purpose. But though, for establishing a really natural system, every stage of an animal's development and all its parts ought to be studied and taken into account, surely a systematist ought to aim at founding his classification as far as possible on the most accessible stages and the parts most easily observed. At any rate the general student will have little inclination to arrange his collection by investigating in the different specimens the walls of the stomach and the teeth and hairs within it, although he may occasionally be pleased to observe in that of the lobster the three horny-looking grinders, the central one

[1] Spence Bate. *Report on the Macrura* collected by H.M.S. *Challenger*, p. xlviii.

of which has from of old been fancifully called 'the lady in the chair.' The character of all the internal organs of

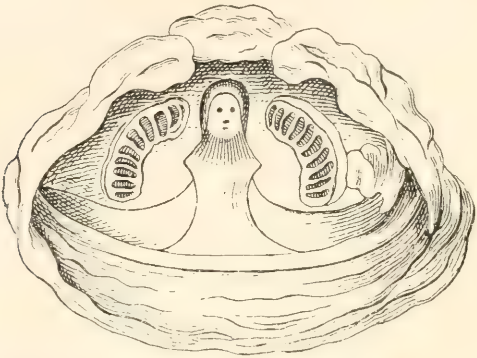


FIG. 1.—A lobster's stomach opened to show the teeth, the central one of which has been supplied with eyes, nose, and mouth, to represent 'the lady in the chair.' [Herbst]

a crustacean, as exemplified in the crayfish, has been already discussed in detail by Professor Huxley in a previous volume of this series. It may here, therefore, suffice to recall that in a crustacean the heart is dorsal, the nerve-chain, with the exception of the brain, ventral, and the alimentary canal central, having in proximity the hepatic lobes or liver, and the testes and ovaries. Some of the more or less striking peculiarities which prevail in different groups in regard to these organs are reserved for mention as occasion offers in the description of the several sub-orders and their families.

The following table supplies a synopsis of all the leading groups of the Crustacea. The literal meaning of the various names has been explained in the first chapter :—

Class.

CRUSTACEA.

Sub-classes.

Malacostraca. Entomostraca. Gigantostraca.
Thyrostraca (or Cirripedia).

MALACOSTRACA.

Orders.

Podophthalma.	Edriophthalma.
Sub-orders.	*Sub-orders.*
Brachyura.	Cumacea.
Macrura.	Isopoda.
Schizopoda.	Amphipoda.
Stomatopoda.	

ENTOMOSTRACA.

Orders.

Branchiopoda.	Ostracoda.	Copepoda.
Sub-orders.	*Sub-orders.*	*Sub-orders.*
Phyllocarida.	Podocopa.	Gnathostoma.
Phyllopoda.	Myodocopa.	Pœcilostoma.
Cladocera,	Cladocopa.	Siphonostoma.
Branchiura.	Platycopa.	

GIGANTOSTRACA.

Orders.

Merostomata. Xiphosura. Trilobita.

THYROSTRACA (CIRRIPEDIA).

Orders.

Thoracica.	Abdominalia.	Apoda.	Rhizocephala.
Sub-orders.			
Pedunculata.			
Operculata.			

CHAPTER V

THE SUB-CLASS MALACOSTRACA

THE head and trunk are together composed of thirteen, or, if an ophthalmic ring be included, of fourteen segments. The caudal part or pleon is composed of six segments and a telson. The trunk is clearly distinguished from the pleon, but some part of it is always more or less closely united with the head. To every segment normally belongs a pair of jointed appendages. The eyes are either pedunculate, and limited to two in number, with rarely a pair of accessory ocelli, or they are sessile, and then generally two, but sometimes four, or with the components variously distributed. There are two pairs of antennæ, a pair of mandibles, and two pairs of maxillæ. Of the next eight pairs of appendages, from one to three are maxillipeds, organs of the mouth, the remainder, from seven to five in number, being prehensile or locomotive. All these are typically seven-jointed. Like the second antennæ and second maxillæ they may either have or be without an exopod on the second joint, and they may also have or be without an epipod on the first. The six pairs of appendages of the pleon, when present, generally have an exopod. The last pair almost always differs in character from the rest. The paired appendages of the mouth work from the sides, the oral aperture itself being fringed by the labrum or upper lip above, and the bifid labium or lower lip below. A short œsophagus leads up into the stomach. The intestinal tube terminates in the under side of the telson. The heart which is dorsally placed has lateral openings for the entrance of the blood that has been oxygenated in the branchiæ. These slits are in one, two,

or three pairs, only in the Squillidæ exceeding that number. The ganglia of the same pair are situated close to one another, though the commissures may stand a little apart. By the dorsal and lateral extension backwards and generally also forwards of one (or two) of the cephalic segments a shield or carapace is formed covering at least some part of the trunk and sometimes all of it.

The above characters will suffice for a descriptive definition of the Malacostraca, but it may be proper to remind the reader that the segments are sometimes so intimately coalesced that their separate identity is entirely obscured, and that moreover almost any pair of the appendages, even one so seemingly indispensable as the mandibles, may in certain cases be missing. Absence of eyes is by no means infrequent, and the telson, though perhaps never properly speaking absent, is often, by its close union with the preceding segment, so withdrawn from recognition, that in practice it is spoken of as absent.

Order 1.—*Podophthalma.*

In this order there is normally a pair of compound eyes on movable stalks, the eyes being sometimes absent but never sessile; the dorsal shield or carapace extends back over the ninth segment or further.

Sub-order 1.—*Brachyura.*

The carapace extends over the whole head and trunk, with occasional exception of the trunk's ultimate and penultimate segments, and is longer than the pleon. In the carapace are excavated orbits and fossettes, hollows respectively adapted to receive the stalked eyes and the short first antennæ. The third maxillipeds have some of the joints broad and flat, and they form a more or less complete operculum to the well-defined mouth cavity. The following pair of appendages are perfectly chelate limbs, commonly called the chelipeds. The next four pairs are adapted for walking or swimming, or rarely may have a prehensile character. In the sternal plastron, or breast-

plate, the coalesced ventral plates of the last five segments of the trunk are distinguishable, and three earlier segments are obscurely represented. It is never entirely linear. The vulvæ of the females are generally placed upon it, but in some groups are transferred to the basal joints of the ante-penultimate legs. The pleon is of subordinate size, usually reflexed against the concavity of the plastron, in the male generally narrow and pointed, with only one or two pairs of pleopods, in the female broad, with four pairs of pleopods. The basal joint of the first antennæ contains auditory hairs but no otoliths.

In this definition the *Anomura apterura* are included. To the dry bones of definition must be added an even less appetising explanation of terms in common use for the description of genera and species. The orbital regions of the carapace speak for themselves as being those which contain the eyes. The 'front' lies between them. Behind it on the under surface are the fossettes of the first antennæ, followed in the median line by the epistome, the buccal or oral frame, and the sternal plastron. The second antennæ are placed outside of and a little behind the first. The 'hind margin' of the carapace separates the trunk from the pleon, and lies between the first joints of the last pair of trunk-feet. Between it and the orbits are the lateral margins, each of which is subdivided into an antero-lateral and a postero-lateral portion forming, when not continuous, the epibranchial angle. The dorsal surface of the carapace is marked by several grooves corresponding with the insertions of muscles underneath, and also forming the boundary lines of regions which roughly coincide with the positions of important internal organs. Along the centre lie the gastric, cardiac, and intestinal regions, respectively over the stomach, heart, and intestine. The hepatic regions over the liver flank the gastric region on either side in front, and behind these lie the two branchial regions, the 'cervical groove' being that which separates the gastric and hepatic regions from the cardiac and branchial. On the under side the pterygostomian regions, 'the wings of the mouth,' lie between the antero-

lateral margins of the carapace and the buccal frame. Milne-Edwards remarks that the grooves are often emphasised about the middle of the carapace, so as to produce the appearance of the capital letter H, the transverse

FIG. 2.—*Ethusa mascarone* (Herbst). [*Herbst*]

line being the upper boundary of the cardiac region. In some cases the grooves are so arranged as to represent very strikingly a human countenance or the caricature of one, as in the Masked Crab of Great Britain and the grimacing *Ethusa mascarone* of the Mediterranean, which is here shown as depicted by Herbst. Such likenesses the old writers were not at all disinclined to accentuate.

The Brachyura are divided into tribes, in regard to which, however, there is not at present any absolute agreement among naturalists. We shall here arrange them under the names Cyclometopa, Catometopa, Oxyrrhyncha, Oxystomata, Anomala. It is melancholy, but scarcely avoidable, that an alternative list of names should have to be mentioned, for these tribes in the same succession may be called—Cancroidea, Ocypodiidea, Maioidea, Leucosiidea, and Anomura apterura. The subjoined table will be useful for reference.

BRACHYURA.

Tribes.	*Legions.*	*Families.*
Cyclometopa .	Cancrinea .	Cancridæ, Trapeziidæ, Portunidæ, Podophthalmidæ.
	Cyclinea .	Cyclidæ.
	Corystinea .	Corystidæ.
	Thelphusinea .	Thelphusidæ.
Catometopa .		Gecarcinidæ.
		Ocypodidæ.
		Grapsidæ.
		Pinnotheridæ.
Oxyrrhyncha .	Maiinea . .	Inachidæ, Maiidæ, Periceridæ.
	Parthenopinea	Parthenopidæ.
Oxystomata .		Calappidæ.
		Matutidæ.
		Leucosiidæ.
		Dorippidæ.
Anomala . .	Drominea .	Dromidæ, Homolidæ.
	Ranininea .	Raninidæ.

CHAPTER VI

TRIBE I.—CYCLOMETOPA

THE name literally means 'those of a circular forehead.' In these Crustacea the carapace is often of a breadth greater than the length, wide and regularly arched in front, more rarely quadrate or suborbicular, but not rostrate. The epistome is short, transverse. The first antennæ are in general transversely folded. The third maxillipeds have the fifth joint articulated at the apex or the inner front angle of the fourth (except in *Pirimela*). There are nine pairs of branchiæ, with their efferent channels opening at the sides of the endostome or palate. The verges of the male are inserted at the bases of the last legs of the trunk.

Milne-Edwards states that the different ganglia of the trunk form a sort of circular ring, of which it is often easy to distinguish the constituent elements, and that the two halves of the liver remain distinct without a median lobe.

The tribe has been subdivided into four legions—Cancrinea, Cyclinea, Corystinea, Thelphusinea, in defining which I shall follow the safe guidance of Mr. E. J. Miers, as afforded in his report on the Brachyura collected by the *Challenger*.

Legion 1.—*Cancrinea.*

The buccal cavity is usually well defined. The flagella of the second antennæ are not greatly elongated. The seventh joint in the walking-legs is generally unarmed. It is either stiliform or in the last pair expanded into an

ovate swimming organ. The species are marine or littoral.

This legion contains four families—Cancridæ, Trapeziidæ, Portunidæ, Podophthalmidæ.

Family 1.—*Cancridæ.*

The carapace is commonly transverse and convex, with the antero-lateral margins arcuate, and armed with several lobes, teeth, or spines. The 'front' is of moderate width, in general not projecting over the first antennæ and the bases of the second, the latter being seldom excluded from the inner hiatus of the orbits.

In this family are included about half a hundred genera, some widely and conspicuously distinct, others separated by fine and almost inappreciable differences. Thus Mr. Miers observes of *Xantho* (Leach, 1813), that 'it is connected by almost insensible gradations on the one hand with *Lophoxanthus* and *Xanthodes*, on the other with *Panopeus* and *Eurypanopeus*.' Quite recently the genus *Panopeus*, H. Milne-Edwards, 1834, has been reviewed by James Benedict and Mary Rathbun. They recognise in it thirty-eight species, and re-include within its boundaries *Eurytium*, Stimpson, 1859, and *Eurypanopeus*, A. Milne-Edwards, 1880, considering that they have been separated from the parent genus on grounds insufficient or untenable. It will, however, be quite beyond the range of such a manual as this to enter into all the minutiæ of generic distinctions. Far less can the characters of innumerable species be discussed. Only the specially typical or the specially anomalous forms may court a passing attention. Here and there a comparison, a description, a comment, may indicate the variety of details upon which classification is founded, or may suggest the endless opportunities for the exercise of keen eyes and acute minds, which the subject provides.

Those whose scientific zeal is limited to the desire of having the specimens in a cabinet rightly arranged and ticketed with their proper names are often puzzled and

exasperated to find that there is practically no finality in these matters. It is important to remember that this cannot be helped, so long as knowledge is in the stage of growth, the stage in which it is most acceptable to the human intellect, by continually holding out the invigorating hope of new acquisitions. In the progress of science some animal hitherto unknown or little noticed attracts the attention of a naturalist. Describing some of its salient features, he makes it the typical species of a new genus. In course of time many other animals are found to have characters almost identical, and they constitute the various species of the same genus, till the number of them becomes so large that they are perhaps at first grouped in lettered or numbered sections, to which presently names are given as subgenera, and these in turn are raised to the rank of genera, and sometimes eventually to higher grades in the system. At each successive improvement there comes a displacement of the old names, and for the accurate designation of specimens the unskilled are placed at greater and greater disadvantage. There was a time when all the Crustacea were included among insects, but to call a lobster an insect would now be regarded as a proof of ludicrous ignorance. The existing genus *Cancer* is an absurd little remnant of that which was originally established by Linnæus, and which has been gradually subdivided into a long array of genera, and families, and legions, and sub-orders, and orders. Bell, in 1853, in his 'British Stalk-eyed Crustacea,' says, 'There is but one species of this genus, as now restricted, native of the shores of this country, or indeed of Europe, all the others being South American.' He refers, however, to the species discovered by Say, which belong to the East Coast of North America.

The great eatable crab of our own shores is well known. Dr. Leach remarks that 'at low tide they are often found in holes of rocks, in pairs, male and female, and if the male be taken away, another will be found in the hole at the next recess of the tide. By knowing this fact, an experienced fisherman may twice a day take with little trouble a vast number of specimens, after having once

discovered their haunts.' Mr. Couch found that this referred to the mating time, which occurs just after the female has cast her coat, her new shell being still soft. It is easy to understand why the exuviation of the male takes place at a different period, as otherwise the pair would be defenceless together. Of this *Cancer pagurus*, Linn., small specimens are often sheltered in considerable numbers in cavities wrought in the vast masses of the sand-tubes of the marine worm *Sabellaria alveolata*.

Cancer irroratus, Say, is the commonest species of the genus in America. It is exceedingly like the European species, but smaller, with the chelipeds less bulky, and distinguished by a strong tooth on the fifth joint. It is said to be common under the large rocks near low-water mark, often lying nearly buried in the sand and gravel beneath them. It is also frequent on sandy shores, and occurs in the tidal pools, where, according to Professor Verrill, 'the comical combats of the males may sometimes be witnessed.' Miss J. M. Arms founds upon it the following description of a crab's method of walking:—

'The legs of one side are used to push with, and those of the other to pull with, when the crab is in motion. Those of the same side do not, however, all move together, but alternately, so that there is no halting in their gait; some of the legs are always in the act of taking new steps, and by shoving and pulling in unison a continuous motion is kept up. This crawling by means of jointed appendages can be imitated after having once seen a live crab. Cross the two wrists side by side, placing the fingers down on a level table; bind the wrists by an elastic band, hold them well up from the table, so as to show the fingers. Then let one set crawl while the other pushes, so as to keep up a continuous motion sidewise without assistance from the arms. The terminal sections of the legs show wear only on the points where these are inserted in the ground.'

It will subsequently be seen that there are some crabs which are by no means limited to the slow progression denoted by the word crawling.

Say established the species *Cancer irroratus* in 1817, but in 1859 Stimpson discovered that under one name Say had combined two species, having been misled into matching the male of *Cancer irroratus* with the female of *Cancer borealis.* The differences between the sexes which often exist in Crustacea have more commonly led naturalists into the opposite mistake of instituting a separate species for each sex. *Cancer borealis,* Stimpson, occurs in the same localities as *Cancer irroratus,* only being a heavier and more massive species it does not equally court shelter and retirement, but will rest entirely exposed on bare rocks and ledges, or clinging to weeds amid the onset of the waves. Yet the strength of its shell does not save it from the gulls and crows which take advantage of its venturesome position to carry it off for their own consumption.

It is not only the sexes of the adult crustaceans that often differ considerably in appearance, but in many instances between the egg and maturity there are stages to be passed through in which the forms of the young are so startlingly different from those of their parents that they have been placed in different genera, until the relationship was eventually proved or made probable. To these larval stages various names have been given, some of them borrowed from the names of the supposed genera to which the young animals had been at first assigned.

The Dutch naturalist, Martin Slabber, in 1769, was the first to publish an account of a crustacean metamorphosis so striking that, as he says, had he not himself witnessed it, he should have placed the two forms in different genera. Yet this singular observation was left barren, until in 1823 Mr. Vaughan Thompson was induced to follow it up, with results that have since been far-reaching. One very curious circumstance in this history is that the two forms which Slabber figures evidently do belong to perfectly distinct groups, the first or *Zoëa* form to the Brachyura, and the second to the Macrura. Bell, in the Introduction to his 'British Stalk-eyed Crustacea,' reproaches Thompson for coming to the conclusion 'that Slabber lost his Zoëa, in

changing the sea-water, and that the new form came from the added portion.' The second form has been shown to correspond very exactly with the larval stage of a prawn, and from this Bell weakly argues that the observation of Slabber was correct, although the first form, as Bell had reason to know, was the larval stage of a crab, and in this Slabber correctly observed the gradual dwindling of the horns of the carapace. The minuteness and transparency of these infants and the readiness with which they perish will account for the confusion in regard to the principal change into which he appears undoubtedly to have fallen, but it is remarkable that such an error should have been in close agreement with the real facts of the case, that a discovery apparently so full of interest should have been neglected for half a century, and that then, when at length it was placed upon a solid foundation, the facts should have been hotly and stoutly disputed for a long series of years. In 1837 Milne-Edwards was still undecided on many of the details of the question, but as to the statement made by Vaughan Thompson in 1835 that the great French naturalist had been deputed by the Academy of Science to investigate the development of the Crustacea, that he had passed a summer in the Isle of Ré for that purpose, and had come to the conclusion that the Crustacea are born in their permanent forms, in all that, Milne-Edwards retorts, there is not a word of truth. He had never been in the Isle of Ré, he had never denied that *some* Crustacea underwent considerable changes, and he could only hope that Thompson was more careful in his observations than in his quotations. Notwithstanding this sharp denial, Bell in 1853 still sends Milne-Edwards to the Isle of Ré, and wonders that observations which he never made should have led him to conclusions which he did not entertain.

The larval stages of the American *Cancer irroratus* have been studied by Professor S. I. Smith. As might have been expected, they agree very nearly with those of the European *Cancer pagurus*. In its latest stage the *Zoëa* still has a frontal and a dorsal spine that are

very conspicuous, but at an earlier period it has much longer spines on the carapace, and as yet no rudiments of the legs of the trunk or pleon. After many months they attain the final *Zoëa* stage, in which the terminal segment of the pleon is very broad, and divided nearly to the base by a broad sinus, formed by long spiniform diverging processes, at the base of which the sinus is armed with six to eight spines on each side. Shortly before the change into the second or *Megalopa* form, 'they were not quite so active as previously, but still continued to swim about until they appeared to be seized by violent convulsions, and after a moment began to wriggle rapidly out of the old zoëa skin, and at once appeared in the full megalops form. The new integument seems to stiffen at once, for in a very few moments after freeing itself from the old skin the new megalops was swimming about as actively as the oldest individuals. In this megalops stage the animal begins to resemble the adult. The five pairs of cephalothoracic legs are much like those of the adult, and the mouth-organs have assumed nearly their final form. The eyes, however, are still enormous in size, the carapace is elongated and has a slender rostrum and a long spine projecting from the cardiac region far over the posterior border, and the abdomen is carried extended, and is furnished with powerful swimming legs as in the Macroura.' Professor Smith observed a few instances of the change from the megalops or *Megalopa* stage to the young crab. 'The little crab worked himself out of the megalops skin quite slowly. For a short time after their appearance the young crabs were soft and inactive, but the integument very soon stiffened, and in the course of two or three hours they acquired all the pugnacity of the adult. They swam about with ease, and were constantly attacking each other and their companions in the earlier stages.'

Professor Smith has remarked that in 'The Crayfish,' fig. 74 represents the *Zoëa* and *Megalopa* stages of *Carcinus mœnas*, not, as stated by a misprint, those of *Cancer pagurus*.

If the tiny young of the Crustacea attack and destroy one another, it is not for want of innumerable other enemies fitted to keep their numbers in check. As far as the timidity of human experience can decide, the Crustacea in general, though by no means particular as to the food they consume, invite rapacity by the agreeable quality of the food they supply. The enormous spines of the very young and the strong armature of the adults have probably been called into existence in consequence. Where these are wanting or inadequate, the life of the species has been protected by extreme fertility. In *Geryon quinquedens*, Smith, for example, it has been computed that one specimen was carrying no less than forty-seven thousand eggs, and there are other species reckoned to be at least twice as prolific.

To the extensive genus *Xantho* Bell assigns three British species, naming them *florida*, *rivulosa*, and *tuberculata*. But, Montagu's *floridus* having lapsed as a synonym, the first of the three should be named *Xantho incisus*, Leach. The second, on Bell's own showing, ought to be called *Xantho hydrophilus* (Herbst), and of this Couch's *tuberculata* is now held to be a variety.

Ozius, Milne-Edwards, 1834, was a genus established to receive certain species found in the Indian and Australian waters. The name had been given much earlier by Dr. Leach, but without published description. It presents a peculiarity by help of which the large family of the Cancridæ is divided into two sections. The space between the front margin of the buccal frame and the mouth itself was called by Milne-Edwards the prelabial space. By English writers it is called the endostome or palate. In *Cancer*, *Xantho*, and many other genera, this endostome is without distinct longitudinal ridges defining the apertures of the efferent branchial channels, whereas in *Ozius*, *Pilumnus*, *Eriphia*, and others, it has these ridges.

Pseudozius, Dana, 1851, is, as the name implies, a genus that might be mistaken for *Ozius*, but the crests of the endostome do not quite reach the upper margin of the buccal frame. In 1881 the species *Pseudozius Mellissi*

from St. Helena was carefully described by Mr. Miers, who pointed out its resemblance to and differences from *Xantho Bouvieri*, A. Milne-Edwards, a species from the Cape Verd Islands. In 1886 Mr. Miers re-described it, and gave a figure of it in his '*Challenger* Report,' but he then placed it in a new sub-genus *Euryozius*, entitling it '*Pseudozius bouvieri*, var. *mellissii*,' in a hesitating manner identifying it with the species *Xantho Bouvieri* of A. Milne-Edwards. In 1888 Professor Th. Barrois, in his catalogue of the marine Crustaçea of the Azores, once more describes this species, and gives a beautiful figure of it in its natural colour of bright orange-red, with black tips to the chelipeds. He and Mr. Miers are in exact agreement in their descriptions, as two such excellent naturalists were likely to be. But Professor Barrois calls the species *Ozius Edwardsi*, and explains that he had submitted it to the highly competent judgment of M. Alphonse Milne-Edwards, who pronounced it to be a new *Ozius*, of which he had himself obtained a specimen at the Canaries during the expedition of the *Talisman*. It will be consoling to the beginner and the amateur, when involved in perplexity amid species that they cannot name or can only name at random, to find the past masters of the science thus entangled as it were in their own web. For it must not be forgotten that Alphonse Milne-Edwards is acknowledged to be 'the highest authority on the Brachyura,'[1] and yet he leads Barrois to make a new species of that which had been twice described and twice named by Miers, and which had probably been already named and described by Professor Milne-Edwards himself. The instance is significant of the stress, to which the highest powers must sometimes prove unequal, of keeping in mind each individual species of the vast multitude now known, and each individual chapter of the vast literature which records them.

Barrois mentions an interesting peculiarity in this elegant crab. The carapace along the antero-lateral margins is obliquely striated on the under side with fine parallel grooves, in correspondence with which the fifth joint or

[1] Miers, *Challenger Report*, p. 146.

wrist of the chelipeds has a long sharp crest and the rapid rubbing of this crest against the striæ produces a shrill sort of stridulating noise such as a grasshopper makes by drawing the thighs of its hind legs over the salient nervures of its wing-cases.

Pilumnus, Leach, 1815, is represented in Great Britain by the single species *Pilumnus hirtellus* (Linn.), but for the world at large more than eighty forms have been described under separate specific names, and still await the discriminating criticism of some future monographer. In this genus, as at present defined, the antero-lateral margins are normally armed with spines instead of the usual teeth, and the pleon is seven-jointed in both sexes. But when the description and figures of *Pilumnus xanthoides*, Krauss, 1843, are examined, they exhibit not spines but rounded teeth or lobes on the antero-lateral border, and a five-jointed pleon in the male. Thus there is *primâ facie* reason to suppose that this species ought to be removed to some other genus. Otherwise the boundaries of the existing genus must be enlarged, whereas for convenience they rather require to be narrowed.

Pirimela, Leach, 1815, like *Pilumnus*, is represented in Great Britain only by a single species, *Pirimela denticulata* (Montagu), which occurs also in the Mediterranean, but, unlike *Pilumnus*, it is not represented by any other species elsewhere. In this genus the pleon of the female is seven-jointed, but that of the male five-jointed, the three middle joints being coalesced into a single piece. It differs from all the rest of the Cyclometopa in the character of the third maxillipeds, for here the fourth joint receives the articulation of the fifth on its inner instead of on its apical margin.

Family 2.—Trapeziidæ.

'Carapace depressed and nearly quadrilateral, smooth, with the postero-lateral angles truncated, the dorsal regions not defined; the antero-lateral margins are straight, form a right angle with the front, and are entire or have but one tooth (the lateral epi-branchial tooth) developed. The

front is -rizo. al, broad, lamellate, and projects over the antennules and bases of the antennæ, which are widely excluded from the orbits.'

The genera are *Trapezia*, Latreille, 1825, *Tetralia*, Dana, 1851, and *Quadrella*, Dana, 1851, names indicative of the prevailing shape. The species in general are small and confined to the warm seas. According to the Russian 'ter, Paulson, 1875, the lower antennæ of *Tetralia* re- · that the last clause of the above-quoted definition l be cancelled.

Family 3.—*Portunidæ.*

The carapace is depressed, moderately transverse, and usually widest at the last antero-lateral marginal spine. The 'front' is horizontal and not spatuliform (see p. 71). The orbits and eye-stalks are of moderate length. The spine or tooth at the outer angle of the orbit does not project laterally beyond the teeth of the antero-lateral margin, of which more than one, usually from five to nine, are developed. The last legs of the trunk are commonly adapted for swimming, with the seventh joint ovate, flatly expanded.

The Portunidæ include about half as many genera as the Cancridæ.

Carcinus, Leach, 1813, has the seventh joint of the fifth legs narrowly lanceolate. The species *Carcinus mænas* (Pennant) is the most obtrusive of all the British Brachyura. Its numbers justify its English designation as the *Common Shore Crab*; its extremely vivacious movements and its reckless audacity when brought to bay justify its scientific title and the corresponding French name for it of *Crabe enragé*. In the early part of this century Leach stated that it was sent to London in immense quantities and eaten by the poor. Professor Stalio says that at the present day it is a considerable source of food-supply to the humbler classes on the shores of the Adriatic, that in the soft state, just after the shedding of the skin, it is welcome at the tables of the rich, and that the Istrian fishermen pound it up and use it as a most attractive bait to the sardines. On

the other hand, complaints are made by English writers of the mischief which it does to fish already captured, and Dr. Hoek accuses it of the truly detestable crime of invading the oyster beds, and eating the young oysters while their shells are still soft and easy to break. In attacking the adults, it is itself sometimes caught by the snapping down of the powerfully hinged valves.

The only other species of this genus known is the American *Carcinus granulatus* (Say), and even this may not be really distinct from the European form.

Portunus, Fabricius, 1798, has the last two joints of the fifth legs dilated and compressed, and the last joint ovate. It is by this formation that many of the Portunidæ are qualified as swimming crabs. In the Caribbean Sea, and among the gulf weed in the tropical Atlantic, Mr. Gosse observed them shooting through the water almost like a fish, 'with the feet on the side that happens to be the front all tucked close up, and those on the opposite side stretched away behind, so as to hold no water, as a seaman would say, and thus offer no impediment to the way.' Our British species swim with less facility, and are often called *fiddler crabs*, because, as Mr. Gosse explains, 'the see-saw motion of the bent and flattened joints of the oar-feet is so much like that of a fiddler's elbow.' The beautiful Velvet Crab, *Portunus puber* (Linn.), called in the Channel Islands the Lady Crab, is for ordinary purposes sufficiently described by Bell in the 'British Stalk-eyed Crustacea,' together with six other species of the genus that have been obtained in the waters of Great Britain, namely *depurator* (Linn.), *corrugatus* (Pennant), *arcuatus* and *pusillus*, Leach, *holsatus*, Fabricius, and its near ally *marmoreus*, Leach. To these Canon Norman has added *Portunus tuberculatus*, Roux, from the Shetland Isles. He remarks on the singularity of the circumstance that this and many other southern forms should be found in the deep Shetland waters, though they are not known from localities between those waters and the Mediterranean.

Portumnus, Leach, 1814, both by name and structure, closely approaches the preceding genus, but it has the

last joint of the fifth legs lanceolate. The British species which Bell names *Portumnus variegatus*, Leach, he ought in accordance with the rules of priority to have called *Portumnus latipes* (Pennant). In distinguishing *Portumnus* from the closely allied *Platyonichus*, Latreille, 1818, Bell or his printer has made a confusing mistake by attributing to *Platyonichus* the acutely lanceolate terminal joint in the fifth pair of legs, and the broad oval, very much rounded joint to *Portumnus*, instead of putting the contrast the other way round (see Plate II.). He mentions that in *Portumnus*, as in many other Portunidæ, the pleon of the male is five-jointed, whereas in *Platyonichus* it is seven-jointed. Unfortunately this distinction, which would have been so convenient, only applies to two out of the three species which are now allotted to the latter genus, namely to *Platyonichus bipustulatus*, Milne-Edwards, and to *Platyonichus iridescens*, Miers, a species in which the legs are said to be beautifully iridescent.

Platyonichus ocellatus was first described in 1799 by Herbst, who records its habitat in the words, 'Das Vaterland ist Long-Eiland bey Newyorck.' Both New York and the 'Lady Crab' of America have come to be better known than they were in the time of Herbst. Verrill and Smith, in their valuable report on the invertebrate animals of Vineyard Sound, give a figure of the crab and many interesting particulars. It is, they say, perfectly at home among the loose sands at low-water mark, and also abundant on sandy bottoms off shore. It is a rapid swimmer, and was not unfrequently taken on the surface of the sea. 'When living at low-water mark on the sand beaches it generally buries itself up to its eyes and antennæ in the sand, watching for prey or on the look-out for enemies. If disturbed, it quickly glides backward and downward into the sand, and disappears instantly. This power of quickly burrowing deeply into the sand it possesses in common with all the other marine animals of every class which inhabit the exposed beaches of loose sand, for upon this habit their very existence depends during storms. By burying themselves sufficiently deep

they are beyond the reach of the breakers.' 'The *lady-crab* is predacious in its habits, feeding upon various smaller creatures, but like most of the crabs it is also fond of dead fishes or any other dead animals. In some localities they are so abundant that a dead fish or shark will in a short time be completely covered with them, but if a person should approach they will all suddenly slip off backwards and quickly disappear in every direction beneath the sand; after a short time, if everything be quiet, immense numbers of eyes and antennæ will be gradually and cautiously protruded from beneath the sand, and after their owners have satisfied themselves that all is well, the army of crabs will soon appear above the sand again, and continue their operations. The colour of this crab is quite bright, and does not imitate the sand, probably owing to its mode of concealment. The ground-colour is white, but the back is covered with annular spots formed by specks of red and purple. It is devoured in great numbers by many of the larger fishes.'

Polybius, Leach, 1820, is closely related to the three preceding genera, and like the last has the capacity for swimming highly developed. The single species, *Polybius Henslowii*, Leach, is European, and is distinguished by having much compressed joints not only in the last pair of legs, but also in the three preceding pairs. It is said to pursue fishes so active as the mackerel, to fasten upon them with its sharp pincers, and to hold on till they succumb. The fishermen in consequence call it the nipper crab. Probably it is only fish that are terrified or hampered by the proximity of the fishing-net that fall victims to its agility. The Prince of Monaco records that on one occasion, off the coast of Spain, his bursting trawl-net brought up from a considerable depth at a single haul about five thousand fine specimens, which produced an animated scene on board his yacht by nimbly fastening with their cat-like talons on to the bare toes and fingers of the crew.

Scylla, de Haan, 1833, belongs to a group of genera in which the carapace is very broad, and the antero-lateral margins are armed with nine or more teeth. Some of the

species are strikingly handsome, both in shape and colour. *Scylla serrata* (Forskål), a widely distributed Indo-Pacific species, is said by Krauss to be the largest and strongest of the South African Crustacea. The chelipeds of the male are much larger and more powerful than those of the female, and colossal in relation to the carapace. The damaged limbs and bodies covered with scars, uniformly exhibited by male specimens, are adduced in support of the inference that their combats one with another are not a little intemperate. On the muddy coasts of the Bay of Natal, Krauss says, this species lives in great deep holes, and wears the dingy earthy colour of its residence. They sit at the openings of their holes when the tide is coming in to snap up the food which it brings them, and to sun themselves when the tide is going out. At any one's approach they vanish into their holes in a moment, or, if their escape is cut off, they raise themselves up on their hind legs, and by clashing together their powerful claws endeavour to scare away the intruder. By driving a spade into their slanting tunnels their retreat may be cut off; or they will clutch at the proffered point of a stick and may so be drawn out, but the Caffres, who consider them dainty food, capture them by spear-throwing.

Charybdis, de Haan, 1833, belongs to a group of genera in which the carapace is said to be only moderately broad, and the antero-lateral margins have seven teeth or fewer. However, in *Charybdis cruciatus* (Herbst), the carapace is of very considerable breadth. The colouring of this species is highly remarkable. Herbst in 1796 gives a fine picture and a glowing description of one of the specimens which he received from the East Indies. The colours in the plate are vivid, but it cannot be said that they tally in all respects with the verbal account. According to the latter, the carapace from the front to beyond the middle of the field is of blood-red hue upon a yellowish ground, and marked with the figure of a great yellowish white cross. Down the sides run broad stripes of greenish red, shading off into grey. The upper surface of the chelipeds is marbled with yellow and red, the hands

having deep red patches and interlacing lines. The following pairs of feet are yellowish with faint red lines, the last pair being marbled with red, its joints very broad, and the last of them thin and membranous. By some writers this species is called *Goniosoma cruciferum* (Fabricius). They would displace de Haan's *Charybdis*, not because of any pre-occupation of that name, which would have afforded a just reason, but because a different name *Charybdea* had been previously employed, which is no reason at all for cancelling *Charybdis*. Again, they would displace the earliest specific name *cruciatus* as inappropriate, whereas, they argue, the name *cruciferum*, given by Fabricius, is in accordance with the great pale cross marked upon the carapace. It is true that Herbst probably tortured the meaning of *cruciatus*, but it is quite clear that he intended it to bear the sense of *cruciferum*, and even if he had chosen to regard his crab as fixed to a cross instead of regarding the cross as fixed on the crab, it would not have justified any tampering with the name and the rights of priority. It is perhaps this species that suggested the story found in the old writers that on one occasion, to calm the sea, Xavier threw a crucifix into it, and that this was afterwards restored to him by a crab.

Bathynectes, Stimpson, 1871, with a name that means 'the deep swimmer,' is closely akin to *Charybdis*, but its antero-lateral margins have only five teeth, the hindermost of which is very prominent, being twice as long as those which precede it. *Thranites velox*, of which in 1876 and 1881 Professor Carl Bovallius gave a detailed description, illustrated by numerous excellent figures, has since been found to belong to Stimpson's *Bathynectes*. The detailed description is in Swedish, the excellent figures are in a language which all but the blind can read with ease. The species has been identified with Stimpson's *Bathynectes longispina*, 1871, but Canon Norman has recently made it probable that the priority rests with *Portunus superbus*, O. G. Costa, and that the name will, therefore, be *Bathynectes superbus*, the species having 'a range apparently co-extensive with the North Atlantic,'

and belonging to the British fauna as well as the Neapolitan in which it first was named. Another Mediterranean species, *Portunus longipes*, Risso, which is also found on British coasts, and which is figured and described by Bell in the 'British Stalk-eyed Crustacea,' p. 361, is now called *Bathynectes longipes.*

Family 4.—Podophthalmidæ.

The carapace is widest anteriorly, with the 'front' very narrow, spatuliform, and inflexed. The orbits are extremely large, and the eye-stalks greatly elongated, occupying nearly the whole width of the carapace.

Podophthalmus, Lamarck, 1801, contains but one recent species, the widely distributed Indo-Pacific *Podophthalmus vigil*, Fabricius. The long eye-stalks almost meet at their bases, and consequently the 'front' is there almost linear, but it is prolonged for a short distance below and transversely dilated, so that, if straightened out, it might be compared to a battledore, or a broad-bladed knife, a spatula, whence the expression *spatuliform* has been applied to it. The great breadth of the short carapace, the very large denticulate chelipeds, and the unusual though not unparalleled length of the eye-stalks, make this a conspicuous and attractive species. According to Miers (1886) the only other genus that can claim a place in this family is *Euphўlax*, Stimpson, 1860, the name of which, meaning a good watchman, corresponds with the family character.

Legion 2.—Cyclinea.

The carapace is more or less orbiculate.

Acanthocyclus, Milne-Edwards and Lucas, 1843, has for its type species *Acanthocyclus Gayi*, which occurs commonly on the shores of Chili and Patagonia, and in the Straits of Magellan. In this the eye-peduncles are short; no longitudinal ridges are developed upon the endostome; the 'front' is rather narrow, with a prominent median lobe; in the third maxillipeds the third joint is much longer than the small fourth one; the pleon of the male is narrow

and five-jointed. Mr. Miers says, 'The nearest ally to *Acanthocyclus* is, I think, *Bellia* [Milne-Edwards, 1860], which resembles *Acanthocyclus* in the more or less orbiculate carapace, in the form of the front, chelipedes, and ambulatory legs, but is distinguished by the narrower, more elongated merus [fourth joint] of the exterior maxillipedes, by the broader post-abdomen [pleon] of the male, and the less distinctly defined buccal cavity.'

The legion Cyclinea, which cannot boast with certainty of more than a single genus and single species, may hope to have its ranks filled up in the course of time. At present it does not make a very good show, even on paper.

Legion 3.—Corystinea.

The second antennæ have elongate flagella. The third maxillipeds usually do not make a complete closure of the mouth-cavity and are extended over the anterior margin of its frame. The sternal plastron is narrow. The single family Corystidæ does not require a separate definition. It does not appear to contain more than eight genera, three of which are included in the fauna of Great Britain. *Corystes*, Latreille, 1803, has a very distinguishing character as compared with the forms previously discussed, in that the carapace is not transverse, but much longer than it is broad. *Corystes cassivelaunus* (Pennant) has frequently attracted attention by the amusing resemblance of the carapace to a human countenance, which Herbst compares to the broad-nosed Kalmuck type. It is in Great Britain a convenient species for study, from the number of dead specimens that are often cast up on sandy shores. The sexes are easily distinguished. In the male the chelipeds are enormously elongated, and the pleon is very small and has only five joints, although it is quite plain that the central one of the five is in reality a compound of three that have coalesced. In the female the pleon, though small, is broader than in the male, and has the seven joints distinct; the openings of the vulvæ can without difficulty be observed on the plastron between the third pair of legs;

the chelipeds are of no unusual length. The very long external antennæ are a special feature of this crab. When

FIG. 3.—*Corystes cassivelaunus* (Pennant), a female specimen, with the *features* on the carapace slightly accentuated. [Herbst.]

the animal is burrowing in the sand according to its wont, the flagella of these antennæ are brought close together, and the tips alone project from the funnel of the burrow. They are provided with stiff hairs on the inner margin, which no doubt assist in maintaining the funnel-opening of a due width. The joints of the peduncle can be strongly bent, and by this means, as Mr. Couch observed, the hairy fringes of the flagella can be made to brush one another

down and clear away any clinging particles of sand. Mr. David Robertson had a female of this species alive in his possession for seven months, and, so far as his observation went, it would lie buried for weeks without seeking to change, the antennæ clasping into each other to form the tube necessary for its breathing, by giving access to the water above. Through this tube he was also fortunate enough to see the ova sent up, and he infers that the animal at the proper time places them within the influence of the current which its breathing apparatus must constantly maintain. He notices that the pleon by its small size is less fitted to cover the ova than is generally the case among the Brachyura, but that this is compensated and accounted for by the burrowing habit.

In a very young specimen, scarcely three tenths of an inch long, the 'front' quite differs from what is seen in the adult, being produced into a conspicuous rostrum as in the genus *Galathea*, and the telson, instead of being rounded, is broadly emarginate. As two genera, *Nautilocorystes* and *Pseudocorystes*, were so named by Milne-Edwards in 1837, to indicate their great resemblance to the earlier genus *Corystes*, it may be interesting to point out some of the differences by which the three are distinguished, and which in the early days of classification would probably have passed unnoticed.

Corystes.—The third maxillipeds have the fourth joint longer than the third, with the fifth joint inserted in a deep notch of its inner margin considerably below the apex. In the fifth pair of legs the seventh joint is narrow.

Nautilocorystes.—The third maxillipeds have the fourth joint a little shorter than the third, with the fifth joint attached at its apex. In the fifth pair of legs the seventh joint is widened.

Pseudocorystes.—The third maxillipeds have the fourth joint much shorter than the third, small, triangular, with the fifth joint attached near the apex. In the fifth pair of legs the seventh joint is widened.

The species *Pseudocorystes armatus*, Milne-Edwards, was found at Valparaiso, and Milne-Edwards supposes that it may be the same as the 'Grass Crab,' figured by Browne in his 'History of Jamaica,' pl. 48, fig. 2.

Atelecyclus, Leach, 1813, is a member of the family in which the third maxillipeds, contrary to the family custom, *do* make a complete closure of the mouth-cavity. The type species, *Atelecyclus septemdentatus* (Montagu), was first observed on the south coast of Devon. Its carapace is nearly circular. Leach says that to the fishermen it is well known by the name of *old man's face crab.* The antero-lateral margin on each side is furnished with nine teeth, and probably for this reason Leach thought himself justified in changing the name to *heterŏdon*, in which he has been followed by Bell. Montagu perhaps did not think that the point at each extremity of the series ought to be counted in, and at any rate no one can be injured by the retention of the name which it was his privilege as the discoverer of the species to choose.

Thia, Leach, 1815, is represented both in the Mediterranean and in British waters, probably by one and the same species, called *Thia polita* by Leach in 1815, in allusion to the polished surface of the carapace, but as there is no substantial reason for thinking it distinct from the species described and figured by Herbst as *Cancer residuus* in 1799, its name ought to be *Thia residuus* (Herbst), although some may prefer to call it *Thia residua*, not reflecting that the animals are both male and female, and ignoring the old rule of Latin grammar that the masculine gender is to be preferred to the feminine. In this species, which like *Corystes* is a sand-burrower, the pleon is very narrow in both sexes, and, though in the male it is only five-jointed, the transverse grooves of the composite joint are so strongly marked, that all the seven joints might at first glance be thought to be distinct, as they are in the female.

To conclude the discussion of the names used in this family, it may be mentioned, first, that although de Haan rightly claims priority for *Dicĕra* which he established

in 1833 over *Nautilocorystes* instituted by Milne-Edwards in 1837, yet *Dicĕra* must give way, having been already earlier used in other classes of zoology; and secondly, that *Oëidia*, de Haan, 1833, a name meaning egg-like, must likewise be cancelled, having been found to be a synonym of *Gomeza*, Gray, 1831, a Corystid genus of the Japanese fauna.

Legion 4.—Thelphusinea.

The carapace is more or less dilated at the branchial regions; the third maxillipeds have the fifth joint articulated at or near the front inner angle of the fourth or at its apex. The fingers of the walking legs are usually spinuliferous; the verges of the male pass directly through the basal joint of the fifth pair.

The species are fluviatile or live in damp forests.

Family Thelphusidæ.

This being the only family has the characters of the legion. *Thelphusa*, Latreille, 1819, contains numerous species, of which Mr. Miers observes that 'one, the common *Thelphusa fluviatilis*, occurs not only on the shores of the Mediterranean, but also in Asia Minor, Syria, and Persia; the others are found in all the warmer temperate and tropical regions of the old world, extending southward to the Cape of Good Hope, Madagascar, and Australia, but not to New Zealand; a species (*Thelphusa chilensis*) occurs in Chili.' *Potamonautes*, Macleay, and *Geothelphusa*, Stimpson, are so closely related to *Thelphusa* that their separation from it remains a matter of doubtful expedience.

Krauss remarks that the Thelphusidæ are especially fond of clear running streams in which they shelter themselves under stones and plants. They are easily scared, and in spite of their monstrous chelipeds their long peræopods carry them off at a great pace. The pearly Thelphusa (*Thelphusa perlata*, Milne-Edwards) has an earthy greenish colour, which matches its surroundings in the rivulets, whereas *Thelphusa depressa*, a species

which Krauss found at a waterfall in Natal, is yellowish and orange-coloured, in accordance with the cushions of moss among which it has its residence. *Thelphusa dehaanii*, White, occurs in the paddy fields of Japan, and has been taken at an elevation of 2,500 feet above the sea-level. It has been already mentioned that the river crab of Europe is good eating. Milne-Edwards supposes that it was to this crustacean that Aristotle referred under the name Carcinus Heracleoticus.

Paratelphusa, Milne-Edwards, 1855, was at first supposed to be a marine genus, but has since been proved to be an Indo-Malayan genus of fresh-water crabs, several species of which have been described by Mr. Wood-Mason. They differ from the rest of the Thelphusidae in having the distal end of the fourth joint of the chelipeds armed with a sharp spine, and are also said to have a greater general resemblance to some of the Cancridæ.

Dr. de Man, in his elaborate Report on the Podophthalmous Crustacea of the Mergui Archipelago ('Journ. Linn. Soc.' 1887, 1888), includes the genus *Thelphusa* in the next tribe, and the same arrangement is followed by Dr. Camil Heller in his 'Crustacea of the *Novara*,' 1865, the Thelphusinea being in fact intermediate in structure between the Cancridæ and the Gecarcinidæ.

CHAPTER VII

TRIBE II.—CATOMETOPA

THE 'front' is bent downward. The carapace is broad anteriorly, often subquadrate, sometimes subglobose, truncate or arcuate forwards, but not rostrate. The epistome is short, often almost linear. The pairs of branchiæ are usually fewer than nine in number; the efferent channels open at the sides of the endostome. The third maxillipeds have the fifth joint articulated at the front outer angle of the fourth, or less frequently at its apex, or very rarely at the front inner angle. The male verges are inserted either in the sternal plastron, or in the basal joints of the last pair of legs, thence passing through channels in the sternum beneath the pleon.

The tribe contains four families, the Gecarcinidæ, Ocypodidae, Grapsidæ, and Pinnotheridæ. The liver is said by Milne-Edwards to be in general central, extending little or not at all over the branchial cavities.

Family 1.—*Gecarcinidæ.*

The carapace is dorsally very convex, especially dilated over and in front of the branchial regions, with the anterolateral margins usually entire and strongly arcuate. The 'front' is of moderate width and strongly deflexed. The orbits and eye-stalks are of moderate size. The third maxillipeds have the fifth joint articulated at the front outer or near the front inner angle or at the apex of the fourth, which sometimes completely conceals it. The chelipeds in the adult male are powerful, usually unequal. The seventh joint in the walking legs is nearly always

granulated and armed with longitudinal rows of spines. The pleon of the male usually covers the whole space between the bases of the last pair of walking legs.

These land-crabs are called *Toulouroux* by the French. They inhabit the warm territories of both hemispheres. The third maxillipeds suffice without other details to discriminate the genera.

Uca, Leach, 1817. The third maxillipeds have the fifth joint attached at the outer angle of the fourth; the inner edges of the third and fourth joints are in one line; along their outer edges the exopod is externally visible, and has a flagellum.

Gecarcinucus, Milne-Edwards, 1842. The third maxillipeds have the fifth joint attached to the middle of the apical margin of the fourth; the inner edges of the third and fourth joints are in one line; the exopod as in *Uca*.

Cardisōma, Latreille, 1825. The third maxillipeds have the fifth joint attached at the outer angle of the fourth; the inner edges of the third and fourth joints form a re-entering angle; the exopod as in *Uca*.

Gecarcoidea, Milne-Edwards, 1837. The third maxillipeds have the fifth joint inserted in a deep groove of the apex of the fourth; the inner edges of the third and fourth form a re-entering angle; the exopod is without flagellum and concealed beneath the third joint.

Gecarcĭnus, Leach, 1815. The third maxillipeds have the fifth joint attached on the inner margin of the fourth and completely concealed by it; the inner edges of the third and fourth joints form a re-entering angle; the exopod as in *Gecarcoidea*.

Hylaeocarcinus, Wood-Mason, 1874. The third maxillipeds have the fifth joint attached to the middle of the apex of the fourth; the inner edges of the third and fourth form a re-entering angle; the exopod as in *Gecarcoidea*.

In the last four genera it will be perceived that the maxillipeds do not form a complete operculum, but by the arrangement of the inner edges of their third and fourth joints they leave a lozenge-shaped space over the mouth-opening uncovered, while in *Uca* and *Gecarcinucus* the straight inner edges from either side can be brought exactly together so as to close the cavity completely. Mr. Wood-Mason points out that the character of the exopod distinguishes *Gecarcinus*, *Gecarcoidea* (which he calls *Pelocarcinus*), and *Hylæocarcinus* from the three preceding genera, and that they are distinguished from one another by a further character of the maxillipeds, for in *Gecarcinus* the three terminal joints are completely hidden, in *Hylæocarcinus* they are partially visible, and in *Gecarcoidea* completely so.

None of the Crustacea have more attracted the attention and excited the wonder of travellers than some of those belonging to this group. Like the twin snakes that came over the sea and deliberately landed at Troy to slay Laocoon and his two sons, these crabs have, contrary to nature, forsaken the ample waters of the ocean, scorned all the brooks and rivers and lakes, and carried out a portentous invasion of the dry land. Still they are by no means indifferent to moisture. The vaulted part of the carapace over the branchial regions is lined with a very spongy membrane, and sometimes a fold of the membrane along the lower edge of the cavity forms a kind of tube in which water may be held as in a reservoir. But their form and structure are not so surprising as their manners and customs.

Under the heading *Cancer ruricola*, a species of *Gecarcinus*, Herbst brings together many curious particulars, depending largely upon Patrick Browne's 'History of Jamaica.' In the Bahamas, he says, and in tropical regions these land-crabs are so numerous that when they creep out of their holes the ground seems to be in motion. One little island is so full of them that it has been called Crab Island. They are just as frequent in certain districts of Jamaica and in some of the Caribbee islands. The same

was the case at St. Croix, but since the cutting down of the forests and destruction of thousands of the crabs, their number has diminished. They generally take up their abode on the hills, not less than one mile nor more than three miles from the coast. It is in the morning and evening that they are to be found in greatest numbers under the trees. Go away then without a stick in hand, and they will approach with uplifted claws as if threatening an assault. But if they are themselves assailed with a stick or a switch, they retreat, yet still facing the foe, and ever and anon clashing their claws together to strike terror into him. Thus they withdraw to their holes in the rock or the rotten tree or deep burrows in the ground. They are capital eating, and are one of the principal food resources of the natives, who improve the flavour by fattening them up for three or four days in a potato field. But a warning is given that they do not always suit the stomach of Europeans, since they are apt to produce cold hypochondriac humours, whereby some explain the slow melancholy nature of the Caribbee islanders. When seized by a leg or a claw these crabs relinquish it so readily as to produce the impression that their limbs are only stuck on. The lost appendage would be renewed at the next change of skin, but it often happens that the sacrifice which has saved the crab from its human foes exposes it as a defenceless victim to those of its own race.

The pairing season is said to be in March and April. In May, the rainy period, they march in great hosts towards the sea, to bathe and lay their eggs in it. 'Then all roads and brooks are filled with them, and it is indeed a very wonderful instinct, which the Creator has given them, to go direct to that part of the island where there are stretches of sand and slopes from which they can most easily arrive at the sea. Nothing can hinder them from going the straight road towards the sea, for they go over everything that comes in their way, be it hedges, houses, churches, hills or cliffs, straight over everything they go, and rather clamber up at the peril of their lives, than make a circuit. In the night, for example, they will creep in at a window, and

come on to the beds, causing the unwary occupants no small alarm by their clatter. If one has the misfortune to tumble down and damage its limbs, it is immediately eaten up by the rest. It must be a wonderful sight, to see them come down the hills. Everywhere they issue from hollow trees, rotten stems, from under the rocks, and out of innumerable holes. The fields are so covered with them, that unless they are chivied away, there is no setting foot to ground without treading upon them. What with the infinite variety of their markings, their brilliant colours, their sideways gait, their celerity, I know of scarcely any sight comparable with this one. Unless the description of their march has been embellished by the force of imagination, the journey is conducted with as much order as if they had a very experienced commander.' The vanguard, consisting of none but males, starts some days in advance. Then follows the main army, composed chiefly of females, their battalions often covering a space of a mile and a half long by forty or fifty paces broad, and covering it so closely as almost to hide the ground. Some days after, the rear-guard, containing both males and females, closes the vast procession.

Sometimes all the divisions are brought to a halt several days by the want of rain, a want which makes prolonged land-travel impossible to a crustacean. But when Herbst says that these hosts follow the line of the rivers and water-courses, the statement, though highly probable in itself, is scarcely consistent with the miraculous bee-line which he had previously described. If anyone approaches the army and puts it into alarm, these martial crabs draw back facing him, with their claws uplifted and open to be constantly ready for defence. The nip of one of them, it is said, can tear out a piece of flesh, and the claw, even after it has been thrown off by its owner, will continue for a minute to pinch with incredible force. The noise of their march is compared to the rattling of the armour of a regiment of Cuirassiers. Having arrived on the coast, they bathe once in the sea, and then creep into some shelter to rest. The females enter the sea a second time and there deposit their

eggs. These are cast up by the waves upon the sand, and in due course out creep the young crabs, which then cling to the rocks in thousands, but presently quit the water for any suitable places of protection on land, there acquiring strength to follow their mothers up the country.

Patrick Browne says: 'The eggs are discharged from the body through two small round holes situated at the sides, and about the middle of the under shell; these are only large enough to admit one at a time, and, as they pass, they are entangled in the branched capillaments, with which the outer side of the apron is copiously supplied, to which they stick by means of their proper gluten, until the creatures reach the surf, where they wash 'em all off, and then they begin to return back again to the mountains. It is remarkable that the bag or stomach of this creature changes its juices with the state of the body; and, while poor, is full of a black, bitter, disagreeable fluid, which diminishes as it fattens, and, at length, acquires a delicate rich flavour. About the month of *July* or *August* the crabs fatten again, and prepare for mouldering, filling up their burrow with dry grass, leaves, and abundance of other materials; when the proper period comes, each retires to his hole, shuts up the passage, and remains quite inactive, until he gets rid of his old shell, and is fully provided with a new one. How long they continue in this state is uncertain, but the shell is first observed to burst both at the back and sides, to give a passage to the body, and it extracts its limbs from all the other parts gradually afterward. At this time the fish is in the richest state, and covered only by a tender membranous skin variegated with a multitude of reddish veins, but this hardens gradually after, and becomes soon a perfect shell like the former; it is, however, remarkable that during this change there are some stony concretions always found in the bag, which waste and dissolve gradually, as the creature forms and perfects its new crust. A wonderful mechanism!' A footnote remarks that the concretions, which are the well-known gastroliths or crab's eyes, 'are seldom under two or more than four.'

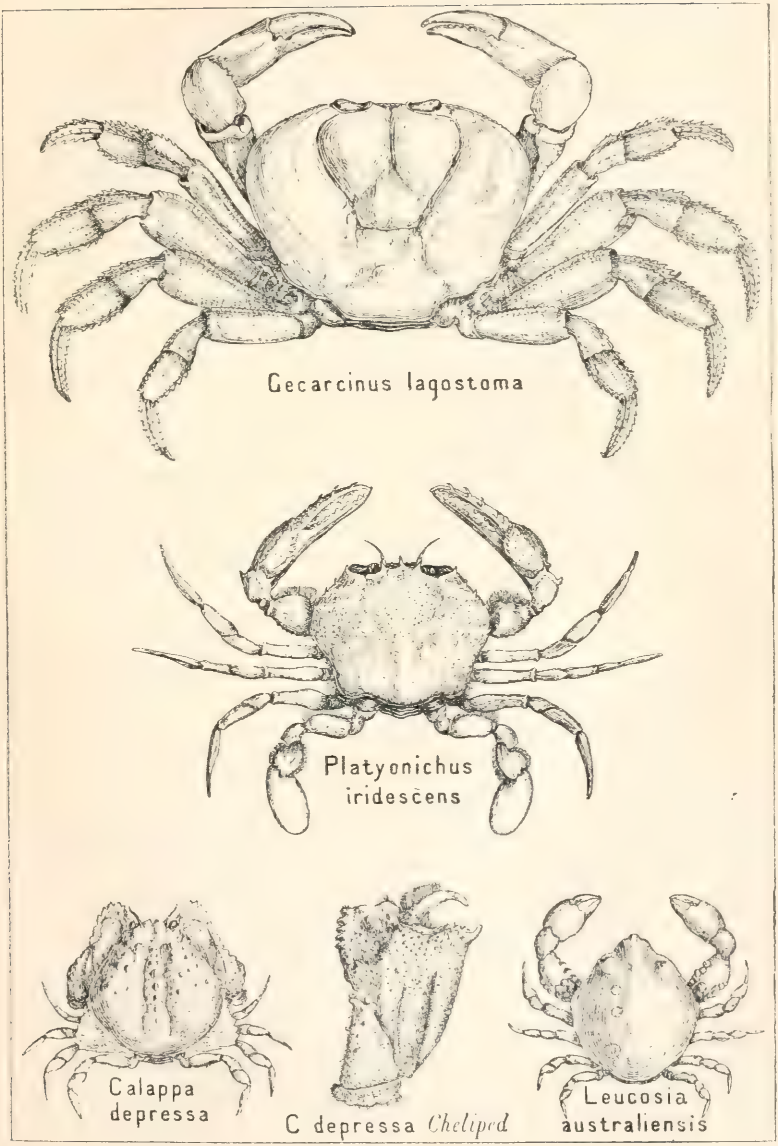
Since it is during this period of 'mouldering' that the crabs are fattest and best flavoured, Herbst finds it easy to suppose that greedy man will not leave them safe in their repose. On the contrary, he busily digs them out with a spade. Considering how readily under some circumstances these crustaceans shed their limbs, it is singular that in exuviation they are able to cast off their whole caparison so uninjured and complete that it might be mistaken for the living animal. Careful inspection is required to perceive near the insertions of the limbs the ventral slit through which the animal has made its escape.

It was in a West Indian species of *Gecarcinus* that Professor Westwood observed that the young issued from the egg in a form not materially different from that of their parents. This experience, combined with Rathke's similar observation in regard to the European crayfish, led him at first to throw doubt upon Vaughan Thompson's theory of crustacean metamorphoses. But it was soon brought to light that the examples of the land-crab and the freshwater crayfish were interesting exceptions to a still more interesting rule, and there are few who would now deny that these exceptions are to be explained as modifications in the life-history of the animals concerned, acquired late in the course of time to suit the new conditions of existence encountered by creatures emerging from the sea to a life in fresh water or on dry ground. That no crustaceans have been able to cut themselves loose from some dependence upon moisture is not very wonderful, since in that respect man himself is still an aquatic animal.

Gecarcinus lagostoma, Milne-Edwards, represented on Plate II, is a widely distributed species.

Hylæocarcinus Humei, Wood-Mason, occurs in 'the dark dense damp forests of the Nicobar Islands.'

Uca una (Linn.), the crab of the mangrove swamps of Brazil, may be mentioned as a rare instance of one that has been allowed to possess the names by which it was figured and described centuries ago. In this genus the last joints of the walking legs are compressed and un-



Gecarcinus lagostoma

Platyonichus iridescens

Calappa depressa

C depressa *Cheliped*

Leucosia australiensis

armed. M. Jobert, in examining the breathing apparatus of land-crabs, has found that of *Uca una* to be the most complete. There is a regular movement of inspiration and exspiration to keep the air from stagnating in the breathing chamber, and between the third and fourth and the fourth and fifth limbs there are small supplemental inspiratory orifices coated externally with long hairs (see Sp. Bate, 'Brit. Assoc. Report,' 1880).

Family 2.—Ocypodidæ.

The carapace is in general moderately convex, cancroid or trapezoidal, with the antero-lateral margins straight or arcuate, the branchial regions not greatly dilated. The 'front' is of moderate width or very narrow. The orbits and eye-stalks are of moderate size or greatly developed. The third maxillipeds have the fifth joint articulated at the front inner or rarely at the front outer angle. The chelipeds in the adult males are in general of moderate size, sometimes slender and elongate. The seventh joint in the walking legs is stiliform, without strong spines. The pleon does not always cover the whole width of the sternum between the last pair of legs.

The species are generally small, littoral, or inhabitants of shallow water, but are not unknown from considerable depths. There are nearly forty genera assigned to the various subdivisions of this family.

Ocypŏdē, Fabricius, 1798, has the orbits very large and open, extending all along the anterior margin on either side of the narrow and deflexed 'front.' The eye-stalks are large, with a short basal joint, the terminal part often prolonged distally as a spine or tubercle, the large corneæ covering much of the lower surface of this terminal joint. The chelipeds in the adult male are unequal and well developed, and usually the palm has a vertical series of short raised lines or tubercles on the inner surface, which form a stridulating ridge.

As the name *swift-of-foot* implies, these Crustacea are especially noted for their rapidity of movement. They are just the opposite of some of the strong-armed, thick-

shelled, slow-moving Cancridæ. On wind-swept stretches of sandy beach, and coloured like the sand, they sometimes seem rather to be borne on the wings of the wind than to run. Also with their compressed lancet-like fingers they are extremely dexterous in digging into the sand. They burrow holes an ell deep, generally perpendicular, and from these they wander far, when the tide is out, in search of food. Krauss observed in South Africa the species *Ocypode ceratophthalmus* (Pallas), and others, and he says that while they are busy hunting, every now and then they look carefully round, raising their stalked-eyes upright, and standing on tiptoe. At the slightest movement towards them they run with uncommon rapidity to the nearest hole, or, if the danger is too close, press themselves flat on the sand, till an attempt is made to seize them, and then off they dart. In running they carry their bodies high, doubling and dodging with such speed and cunning that it is a difficult matter to lay hold of them. When the tide comes up, they are enclosed in their flooded burrows, and as soon as the waves retreat, they are busily employed in clearing them, shovelling out the wet sand and heaping it at some little distance off. The American species, *Ocypode arenaria* (Catesby), is described by Professor S. I. Smith as having precisely similar habits. According to his observation it lives largely upon the Amphipods of the genus *Talorchestia*, known as 'beach-fleas,' which inhabit the same localities. 'It will lie in wait,' he says, 'and suddenly spring upon them, very much as a cat catches mice. It also feeds upon dead fishes and other animals that are thrown on the shore by the waves.'

It is of this species, under the synonym of *Ocypoda rhombea*, Fabricius, that Fritz Müller speaks in his memorable work 'For Darwin.' 'In the swift-footed Sand-crabs (Ocypoda),' he says, '—which are exclusively land animals, that can scarcely live in water for a single day, and which in far less time than that are reduced to a state of complete collapse in which all voluntary movements cease—there has long been known a peculiar arrangement con-

nected with the third and fourth pairs of legs, but that these had anything to do with the branchial cavity was not suspected. These two pairs are pressed more closely together than the rest. The opposed surfaces of their basal joints, that is, the hinder surface in the third, and the front surface in the fourth pair, are flat and smooth, and their margins are closely fringed with long, sheeny, peculiarly formed hairs. Milne-Edwards, who compares them to articular surfaces, as their appearance warrants, thinks that they serve to diminish the friction between the two legs. On this supposition the question arises why precisely in these crabs and only between these two pairs of legs such a provision for diminishing friction is necessary, not to mention that it leaves unexplained the singular hairs, which must augment instead of diminishing friction. While, then, I was bending to and fro in ever so many directions the legs of a large Sand-crab, in order to see in what movements of the animal friction occurred at the place in question, and whether perhaps these were movements often recurring and of special importance to it, I observed, when I had stretched the legs far apart, a round opening of considerable size between their bases, through which air could easily be blown into the branchial cavity or even a slender probe be introduced. The aperture opens into the branchial cavity behind a conical tubercle, which stands above the third foot at the place of a branchia which is wanting in Ocypoda. It is laterally bounded by ridges which rise above the articulation of the legs and to which the lower edge of the carapace is applied. Also outwardly it is overarched by these ridges with the exception of a narrow slit. Over this slit extends the carapace, which just at this point projects further downwards than elsewhere, and so a complete tube is formed. While Grapsus always admits water to its branchiæ only from in front, in Ocypoda I saw it also streaming in through the just described aperture.'

For its details about one particular crustacean such a passage is interesting, but it is far more important as a lesson in scientific observation. There are numbers of

persons who might be familiar with the smooth flat surfaces opposed to one another in the legs of a crab, and who yet would never make the guess that it was an arrangement to diminish friction. With the guess made for them by some one else they would be contented for another lifetime, and so on perhaps with the objection to the guess that if friction was to be avoided, the legs would not have been fringed with hairs. Fritz Müller was well aware of the old principle that Nature makes nothing in vain, and was pretty confident to begin with that there would not at the same point be two arrangements counteracting one another, the one increasing and the other diminishing friction. The smooth surfaces of the limbs enable them to act as tight-closing lips to the breathing-aperture which he discovered at their bases. As to the fringing hairs Fritz Müller hazards the conjecture that they may be olfactory. This might seem a very extravagant supposition, that a crab should have the equivalent of a nose attached to its legs, did we not remember that some crustaceans have organs of hearing in the appendages of the tail. Moreover, Fritz Müller observed that in his *Ocypode* the olfactory filaments in their usual place on the antennæ were much reduced, and that the flagella of the antennæ never make the peculiar beating movements familiar in other crabs, and he argues that in an air-breathing crab, just as in the air-breathing vertebrates, the sense of smell might be expected to have its organ at the entrance of the breathing cavity.

Gelasĭmus, Latreille, 1818, meaning the laughable crab, is a genus containing a large number of species that haunt warm climates. Here, too, the orbits and eye-stalks are long. The pleon in the male is narrow and distinctly seven-jointed, and its base does not occupy the whole width of the sternum between the walking legs. But the most striking feature is the disproportionate size which in the male is attained by either the right or the left cheliped.

According to de Haan his species *Gelasimus arcuatus* is called in Japanese *Siho maneki*, which means 'beckon-

ing for the return of the tide,' because, when the creature is left on the dry shore, by the movement of its claws it seems to be appealing to the waves to come back again. The specific title of *Gelasimus vocans* (Linn.), and the trivial

Fig. 4.—*Gelasimus arcuatus*, de Haan, a male specimen, and pleon of the male detached. [De Haan.]

name, the calling crab, refer to the like action. Of the customs of an American species the following account is given by Professors Verrill and S. I. Smith:—

'On sandy beaches near high-water mark, especially where the sand is rather compact and somewhat sheltered, one of the "fiddler-crabs," *Gelasimus pugilator* [Latreille],

is frequently found in great numbers, either running actively about over the sand, or peering cautiously from their holes, which are often thickly scattered over considerable areas. These holes are mostly from half an inch to an inch in diameter, and a foot or more in depth, the upper part nearly perpendicular, becoming horizontal below, with a chamber at the end. Mr. Smith, by lying perfectly still for some time on the sand, succeeded in witnessing their mode of digging. In doing this they dug up pellets of moist sand, which they carry under the three anterior ambulatory legs that are on the rear side, climbing out of their burrows by means of the legs of the side in front, aided by the posterior leg of the other side. After arriving at the mouth of their burrows and taking a cautious survey of the landscape, they run quickly to the distance often of four or five feet from the burrow before dropping their load, using the same legs as before and carrying the dirt in the same manner. They then take another careful survey of the surroundings, run nimbly back to the hole, and after again turning their pedunculated eyes in every direction, suddenly disappear, soon to reappear with another load. They work in this way both in the night and in the brightest sunshine, whenever the tide is out and the weather is suitable. In coming out or going into their burrows either side may go in advance, but the male more commonly comes out with the large claw forward. According to Mr. Smith's observations this species is a vegetarian, feeding upon the minute algæ which grow upon the moist sand. In feeding, the males use only the small claw with which they pick up the bits of algæ very daintily; the females use indifferently either of their small claws for this purpose. They always swallow more or less sand with their food. Mr. Smith also saw these crabs engaged in scraping up the surface of the sand where covered with their favourite algæ, which they formed into pellets and carried into their holes, in the same way that they bring sand out, doubtless stowing it until needed for food, for he often found large quantities stored in the terminal chamber.'

An earlier observer, Bosc, who studied this same species in Carolina, declares that these crabs were to be seen in thousands and even in millions on the margin of the sea or of tidal rivers. He remarks that, if a man or any animal comes among them, they lift up the large claw, and holding it forward, as if challenging their opponent to fight, in that attitude they scurry off sideways. They have, he says, a great number of enemies among the otters, bears, birds, turtles, alligators, and the like, but they are so prolific that the devastation made among them by these foes is imperceptible. He occasionally saw the 'calling crabs' swarming over a carcase on the shore and disputing with the vultures for strips of the carrion. He was very anxious to see them make their burrows, but they never would work in his presence, doubtless not from shyness, but from some prudential motive. *Gelasimus minax*, Leconte, the largest of the American 'fiddler-crabs,' lives in salt marshes or fresh water. Over the mouth of its burrow Mr. T. M. Prudden ascertained that this crab often constructs a regular ovenlike arch of mud, and that it sits in this doorway on the look out for whatever may befall. Professor Smith kept a large male of this species in a glass jar containing nothing but a little siliceous sand, moistened with pure fresh water, for over six months. It was for ever pacing round the jar and trying to climb out, was never observed to rest or show fatigue, 'and after months of confinement and starvation was just as pugnacious as ever.'

The species *Gelasimus arcuatus*, de Haan, already mentioned, was observed by Krauss in South Africa as occupying muddy ground, and having a bluish-grey colour suitable to its residence. The appropriateness of the generic name will be appreciated in the light of his incidental remark that 'it is truly comical to see these crabs with uplifted arms in countless numbers scampering over the dark mud.'

Gonoplax (originally spelt *Goneplat* and *Goneplax*), Leach, 1814, is a North-Atlantic and European genus, which till lately contained only one species, *Gonoplax*

rhomboides (Linn.), called in Bell's 'History of the British Crustacea' *Gonoplax angulata* (Fabricius), the angular crab, the specific name obviously, and the generic name probably, alluding to the angular character of the carapace. A second species, closely resembling the first, and named *Gonoplax sinuatifrons*, Miers, was obtained by the *Challenger* at Amboina. The elongated orbits and eye-stalks cannot fail to attract attention, and the latter especially when they are suddenly erected from a position of rest within the former. The male has the chelipeds of a remarkable length, and these, at least when in confinement, he is fond of clashing together in a noisy and perhaps threatening manner. The joints of these limbs are so proportioned that while they are able to seize food at a great distance, they can also convey it to the mouth. The pleon is seven-jointed in both sexes.

Ommatocarcĭnus, White, 1852, is distinguished from its near neighbour *Gonoplax* by a still narrower 'front,' a great development of the antero-lateral spine on each side of the carapace, and still more elongate eye-stalks, to which reference is made in the generic name, meaning 'the crab with the eyes.' There is but one species, *Ommatocarcinus Macgillivrayi*, White. This is found in Australian and New Zealand waters.

Macrophthalmus, Latreille, 1829, with a name meaning 'long-eye,' surpasses the two preceding genera in the length of the orbits, and the eye-stalks are exorbitant in the literal sense in certain species, in which they are prolonged laterally beyond the orbit's outer angle. The species are numerous, occurring 'in the littoral or shallow waters of all parts of the Indo-Pacific region.' In some of the species, as also in the genera *Helĭce*, de Haan, 1835, and *Metaplax*, Milne-Edwards, 1852, the males have on the arms of the chelipeds a short horny ridge, which Dr. de Man calls 'the musical crest,' on the supposition that the crab produces musical sounds by rubbing this crest against a row of granules below the orbit. Naturally this crab-music must only be judged by a crustacean standard.

A certain amount of uniformity, especially as regards the flatness of the carapace, may be inferred to exist in this family from the number of genera with names all alike ending in *-plax*, as *Acanthoplax*, *Ilyoplax*, *Hemiplax*, *Camptoplax*, *Bathyplax*, with many others.

The genus *Geryon*, Kröyer, 1837, may claim a passing notice as one of those instances in which systematic arrangement finds itself at fault. It is sometimes placed among the Cyclometopa and sometimes among the Catometopa. Mr. Miers says that it is very nearly allied to *Pseudorhombila* and *Pilumnoplax* in the latter, and to *Galene* in the former group. That, on the theory of the evolution of different groups from a common stem, such inosculant forms are almost sure to occur, has long been recognised. Darwin himself humorously admits that while as a theorist he delighted in coming across them, as a naturalist engaged in classification he found them an unmitigated nuisance.

Family 3.—Grapsidæ.

The carapace is depressed or moderately convex, more or less quadrilateral, with the lateral margins straight or slightly arcuate. The 'front' is never very narrow, in general decidedly broad. The orbits and eye-stalks are of moderate size. The third maxillipeds have the fifth joint articulated at the apex or the front outer angle of the fourth. The chelipeds in the adult male are usually subequal, moderately developed. In the walking legs the seventh joint is stiliform, compressed, and either smooth or spiniferous. The pleon at the base usually covers the whole width of the sternum between the last pair of legs.

The species are almost always littoral or shallow-water forms, with a rare exception in deep water.

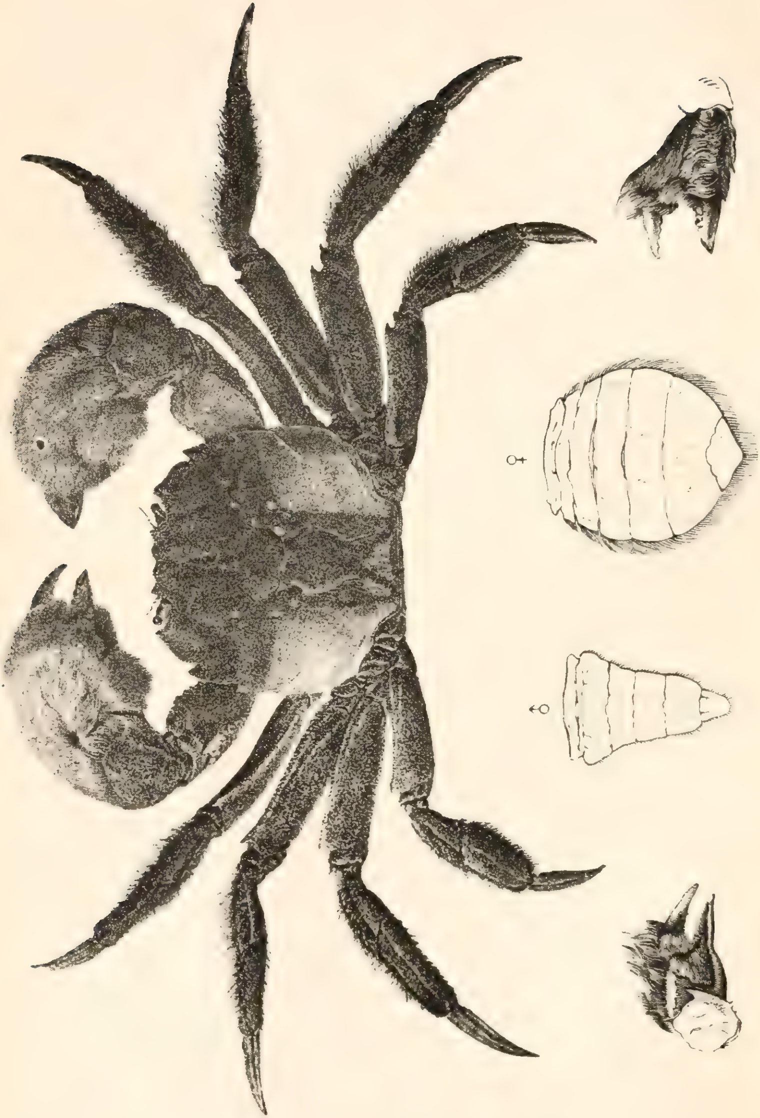
In this family there are about twenty-four genera

Grapsus, Lamarck, 1801, is a wide-ranging genus which was brought to the notice of Europeans a century and a half ago in the species *Grapsus maculatus* (Catesby, 1743 and 1771), to which Bosc in 1802 applied the better

known name of *Grapsus pictus*. Professor Th. Barrois, in his account of the Crustacea of the Azores, speaks of this and two companion species as running with astonishing velocity among the rocks near the sea. The brilliantly coloured *Grapsus*, with its limbs of a marvellous red, he calls a superb species. As it occupies by preference the sides of the perpendicular cliffs, it is easy to believe the statement that prodigies of agility and cunning are required for capturing uninjured specimens. In Charleston Bay Bosc had a much easier task. There he noticed that these crabs almost always kept themselves concealed under stones or pieces of wood, and, as these objects are rare in that locality, every day on the retreat of the tide he was sure to find fresh specimens of *Grapsus* under the hiding-places from which he had taken other specimens on the previous day. Darwin, in 'A Naturalist's Voyage,' when speaking of the nests of the tern at St. Paul's Rocks in the Atlantic, says, 'It was amusing to watch how quickly a large and active crab (Grapsus), which inhabits the crevices of the rock, stole the fish from the side of the nest, as soon as we had disturbed the parent birds. Sir W. Symonds, one of the few persons who have landed here, informs me that he saw the crabs dragging even the young birds out of their nests and devouring them.' The voracity and audacity, the cunning and speed and jumping powers of these crabs of St. Paul's Rocks are amusingly described in the 'Log Letters of the *Challenger*,' by Lord George Campbell, who, however, saw no proof that they ate the young birds.

About a dozen other genera have been formed with names in which *Grapsus* is part of the compound, as *Geograpsus*, *Paragrapsus*, *Platygrapsus*, and the like. Several of these contain species which were at one time included in the genus *Grapsus*, and which are by no means very remote from it.

The *Cancer marmoratus* of Fabricius has been transferred from *Grapsus* to *Pachygrapsus*, Randall, by Stimpson, and to *Goniograpsus*, Dana, by Miers. It is a European species, common among chinks of the rocks in the Adriatic. It prowls about on the shore by night to feed on dead



Eriocheir japonicus, de Haan.

animals cast up by the waves. It is said to be timid, running off with great speed if scared, but if stopped it shows temper and nips hard. It is also very common, according to Lucas, in Algeria, where it is eaten by the poor. Fine specimens for a naturalist's collection are not easy to catch because of their extreme readiness on the least alarm to ensconce themselves deep in rifts of the rock. If in their headlong haste they sometimes slip into a hole too shallow to contain them entirely, the pursuer will still be likely only to obtain their cast-off legs, since they readily relinquish them all rather than be captured.

Nautilograpsus, Milne-Edwards, 1837, like some of the genera previously described, has third maxillipeds which do not form a complete operculum. In 1825, in Bowdich's 'Excursion to Madeira and Porto Santo,' Leach gave to this genus the name *Planes*, a wanderer, but from want of a sufficient accompanying description this has been regarded as technically only a manuscript name, not entitled to priority. It may, however, be doubted whether this is a right decision, since a figure of the type species, *Planes minutus* (Linn.), was appended, and there appears to be but a single species in the genus. The name of wanderer is very appropriate, since this, the common Gulf-weed Crab, is said to occur nearly everywhere on floating weed in the temperate and tropical seas of the globe. If, as is probable, it was the presence of this little crab on the *Sargassum bacciferum* that Columbus adduced as an argument to prove to his despairing sailors the proximity of land, it was not quite so much to the point as the sailors appear to have thought it. Columbus himself had other and more satisfactory reasons for his own confidence. Patrick Browne calls it the Turtle-Crab, remarking, 'I found this insect on the back of a turtle, near the western islands.'

Eriocheir, de Haan, 1835, meaning 'woolly-hand,' contains a species, *Eriocheir japonicus*, of very singular appearance, the great claws looking as if they were muffled up in cuffs of long fur. It is represented in the accompanying plate, which is reduced from de Haan's work.

The detached figures show the chelæ of the young male and the female, and the pleon respectively of male and female. By the Japanese this species is called the mountain savage or the hairy crab. It occupies brackish waters, passing from them into fresh-water streams, by means of which it ascends the mountains, where it is often observed on dry land.

Varuna, Milne-Edwards, 1830, has the single species *Varuna litterata* (Fabricius), common in the Indo-Pacific region, and attracting attention by the marking on the carapace to which the specific name refers. The capital letter H is here considered to be formed with more than usual distinctness by the longitudinal grooves that separate the lateral from the median regions, and the transverse groove which appears to form the upper boundary of the cardiac region.

Sesarma, Say, 1818, includes a large number of species found in the shallow waters of all the warm regions of the globe. In this genus the 'front' is broad; the third maxillipeds, when closed, still leave open a lozenge-shaped space, and have the large fourth joint traversed by a ridge from the front inner angle to the outer angle behind; the pterygostomian regions have a granular or reticulated surface, which in general is divided into little squares of extreme regularity.

Reference has been already made to Fritz Müller's investigation of the breathing arrangements in land-crabs. He was anxious to put the theory of evolution to a test. The resemblances which prevail among all crabs point, on that theory, to their derivation from a common ancestral form, but the differences which prevail in the numerous genera of land-crabs point to a divergence that must have begun long before they assumed terrestrial habits. That, at least, is what Fritz Müller assumes, and few evolutionists will be inclined to deny it. If, then, several different forms of water-breathers at various times and places have independently developed into air-breathers, it is unlikely that the necessary changes will all be of the same pattern. It is so unlikely that, had it proved to be the case, Fritz

Müller was prepared to regard it as a very damaging blow to the theory of evolution. The result was just the opposite, as will be seen by a comparison of his observations on several species and genera. Those on *Ocypode* have been already quoted.

In the family Grapsidæ he describes, under the name *Aratus Pisonii*, the species which Milne-Edwards calls *Sesarma Pisonii*, a sweet little vivacious crab, which climbs the mangrove-bushes and feeds upon their leaves. Its short sharp claws are well fitted for climbing, but they prick like pins when the creature runs over a bare hand. Once, when he had one of these seated on his hand, Fritz Müller noticed that it raised up the hinder part of its carapace, and that by this means a wide slit was opened upon each side over the last pair of feet, affording a view into the branchial cavity. When studying this phenomenon in another species, which he took to be a true *Grapsus*, he observed that with the formation of the slit behind, the anterior part of the carapace seems to sink so as partly or entirely to close the anterior afferent opening. As the lifting of the carapace never takes place under water, he infers that the animal opens its branchial cavity in front or behind according as it requires to breathe water or air. He had noticed the elevation of the carapace, also, in species of *Sesarma* and *Cyclograpsus*, which burrow deep in swampy ground, and often scamper about on the wet mud, or sit watchfully before their burrows. But to observe the action in these is a work of patience, since they can continue to breathe water long after they have quitted the source of supply.

That reticulation of the shell between the afferent and efferent branchial orifices, which has been mentioned in the character of the genus *Sesarma*, has a special purpose. The squared meshes of network are due partly to fine tuberculation and partly to curious geniculate hairs forming over the surface a sort of fine hair-sieve. When the water issues from the branchial cavity it spreads through this network, and can take up fresh oxygen, whereupon the appendages of the third maxillipeds, working in the

afferent opening on either side, by their powerful movements bring it back to the branchial cavity. The two ridges on the maxillipeds, which are often densely fringed with hairs, meet in front and form a triangular breakwater which prevents the streams intended for the branchiæ from entering the mouth-opening.

Of the rock-haunting species of the genera *Plagusia*, Latreille, 1806, and *Goniopsis*, de Haan, 1835, Krauss speaks with a sort of admiration. At low tide they come bustling out of their crannies in hosts. By help of their soft elastic bodies, and their limbs cut out for the very purpose, they clamber over rough blocks and steep sides of rock, jump from one crag to another, and creep into the most inaccessible crevices. They are not very swift, but very canny, so that on their own ground, in spite of their multitude, it is almost impossible to catch any of them. In the fear of pursuit they will let themselves drop several feet from one ledge on to another, or plunge a fathom down into the sea and paddle off to the nearest rock. *Acanthŏpus clavimănus*, de Haan, is a tiny species nearly allied to *Plagusia*, but with different habits. It lurks under stones, and it may seem a light matter to turn over a stone and catch it, but before the stone is well over the crab will have whisked to the other side, and when at length it has been pinned fast, it is no easy task to drag away its thin body and clinging talon-like claws without breaking them. The name of this genus having been preoccupied, it has been changed by Miers to *Leiolŏphus*.

Plagusia contains species that come from the Atlantic and Pacific, and some of these have been taken in the Mediterranean under circumstances worthy of note. In the winter of 1873 an iron vessel entered the port of Marseilles. It had come from Pondichéry, by way of the Cape of Good Hope, having had a long and stormy voyage in the most rigorous season of the year. To the iron plates of this ship had become attached a little forest of algæ and barnacles; and living among these were a number of higher Crustacea of exotic origin. Two of the specimens were found by Professor Catta to belong to a new species

which in 1876 he named *Pachygrapsus advĕna*; one was a *Nautilograpsus* (or *Planes*) *minutus*, a species scarcely ever found in the Mediterranean; the remainder belonged to two species, which M. Catta speaks of as *Plagusia squamosa* and *Plagusia tomentosa*. The latter, a South African species, should rather, it seems, be designated *Plagusia chabrus* (Linn.), and the former *Plagusia depressa* (Fabricius). It was this last-mentioned one that was the most numerous, being present in hundreds. As an Atlantic species, it might not have had far to come. The point of special interest, however, lies, as Catta explains, in showing the effects on distribution that may be produced by unconscious human agency.

Family 4.—Pinnotheridæ.

The carapace is usually more or less membranaceous, convex or depressed, with the antero-lateral margins entire or very slightly dentate. The 'front,' orbits, and eye-stalks are very small. The buccal frame is usually arcuate anteriorly. The third maxillipeds have the fourth joint well developed, and usually the third also, the fifth articulated at the apex, or at the front inner angle, or more rarely the front outer angle, of the fourth. The chelipeds in the adult male are small or moderately developed. The walking legs are slender and generally naked, with the seventh joint stiliform, unarmed. The pleon of the male in general does not cover the whole width of the sternum between the last pair of legs.

The crabs of this family are small, and many of them live in the shells of bivalve molluscs, tests of Echini, tubes of annelids, and other borrowed habitations. Miers distributes five-and-twenty genera over four sub-families.

Pinnothĕres, Latreille (in Bosc), 1802, was known to the ancients under the same name, but more commonly under the name *Pinnotĕres*. It is a great pity that Latreille did not adopt the latter, which is in all probability the older form. Small as the difference in sound, the difference in sense is considerable. *Pinnotheres* means

one that hunts the *Pinna*, and, in accordance with this designation of the genus, Oppian tells the story that when oysters open their valves to take in the mud and water on which they live, one of these crafty little crabs picks up a pebble and thrusts it in, so that the oyster is prevented from closing its shell again, and the crab enters and feeds upon its nutritious flesh. Gesner in the sixteenth century expressed his confidence that this was mythical, since you never find any bites upon the mussels, pectens, pinnas, and oysters that are attended by these crabs.

The name *Pinnotheres* means one that watches or guards the *Pinna*, and there can be little doubt that it was the form used by Aristotle, seeing that he also speaks of it as *Pinnophúlax*, a word of precisely the same meaning. Not only Aristotle, but many succeeding writers of renown, such as Cicero, Pliny, and seemingly Linnæus himself, accepted the opinion that there was a compact between the mollusc and the crustacean for their mutual benefit. Whenever little fishes swam in between the expanded valves of the mollusc, it was supposed that its companion gave it a little friendly nip, upon which the valves snapped together, the prey was secured, and shared between the confederates. A similar policy was pursued to exclude the intrusion of a dangerous foe. The great antiquity of the belief is attested by the fact that the Egyptians in their hieroglyphics made use of the pinna and crab to symbolise the helplessness of a man without friends. That the belief was untenable was pointed out by many naturalists from Gesner down to Cuvier, on the ground that molluscs do not feed on little fishes, and that the residence of the crabs within the valves was sufficiently explained by the prevailing softness of the carapace in this family. This indeed applies chiefly to the females, and it is the females that appear to be most frequently found thus domiciled.

It is so much the nature of crustaceans to take refuge in any sort of cleft or cranny that the first entrance of the *Pinnotheres* into any sort of bivalve can be easily understood. When the residence proved to be peculiarly secure, the shell of the crab would by degrees lose a hardness that

was no longer especially necessary. That the crab may be at times useful to the mollusc seems after all not so very improbable, for at the approach of an enemy so nervous a creature as a crab would no doubt begin to scuttle about and in this way communicate its terror to its more apathetic companion, which would then naturally close its doors against the danger. Dr. H. Woodward has recently recorded a remarkable instance of a *Pinnotheres* found encysted in a pearl-like formation of the pearl-oyster, *Meleagrina margaritifera*.

Pinnotheres veterum, Bosc, and *Pinnotheres pisum* (Linn.) are common European and British species. Giard and Bonnier suppose that under the latter name several distinct species have been confounded. Its Zoëa, long ago studied and drawn by Mr. Vaughan Thompson, is a singular-looking microscopic object. Among the names of other species some which indicate the animal's residence may be mentioned, as *Pinnotheres ascidiicola*, Hesse, from the coast of France, the Japanese *Pinnotheres pholădis*, de Haan, and *Pinnotheres lithodŏmi*, Smith, from the Pearl Islands and Lower California. A similar indication is given in the generic name, *Holothuriophĭlus*, Nauck.

In 'The Civil and Natural History of Jamaica,' when speaking of a *Pinnotheres*, which he calls the Oyster-Crab, Patrick Browne says: 'This little species is generally found with the *Mangrove* oysters, in their shells, where they always live in plenty, and spawn at the regular seasons; and such as eat the oysters, do not think them a bit the worse for being accompanied with some of these crabs, which they swallow with the fish. They are very small and tender, and nearly of the same length and breadth, seldom exceeding a quarter of an inch either way.'

Hymenosōma, Desmarest, 1823, was established under a name invented by Leach, and signifying a membranaceous body. This is a character in which many members of the family partake. *Hymenosoma orbiculare*, Latreille and Desmarest, is a South African species. *Halicarcĭnus*, White, 1846, is closely allied to *Hymenosoma*, but courts

attention for the sake of the species *Halicarcinus planatus* (Fabricius), which is widely distributed over the Antarctic or Austral region, being the only Brachyurous Decapod, it is said, proper to that wide area of distribution. Mr. Haswell considers that the *Elamene Mathæi* of Milne-Edwards is probably the young male of this species, and that it is quite distinct from the original *Hymenosoma Mathæi* of Desmarest.

Scopimēra, de Haan, 1833, was established for the single species, *Scopimera globosa*, in which the arm of the chelipeds and the corresponding fourth joint (the so-called merus) of the hinder legs has the outer margin cartilaginous instead of crustaceous, with a transparent membrane in the flat part. This peculiarity explains de Haan's choice of a generic name, which means 'thighs with windows in them.' From the resemblance to the head of a drum these membranous pieces have been called 'tympana.'

Dotilla, Stimpson, was substituted for *Doto*, de Haan, 1833, a pre-occupied name. In this genus *Dotilla fenestrata*, Hilgendorf, from the East Coast of Africa, has the windows or tympana also in the sternum. *Dotilla brevitarsis*, de Man, is from the Mergui archipelago. Dr. de Man makes *Scopimera* a synonym of *Dotilla*, but, if the two genera are united, *Scopimera* as the older name must take precedence.

Hexăpus, de Haan, 1835, is entirely devoid of the last pair of walking legs, so that instead of decapods these crabs have become octopods, and if the chelipeds are excluded and only the walking legs counted they may be regarded as hexapods, or six-legged crabs, and to this view the name of the genus refers.

Thaumastoplax, Miers, 1881, it is said, 'is closely allied in all its characters and particularly in wanting the fifth pair of thoracic legs, to the genera *Hexapus*, de Haan, and *Amorphopus*, Bell, but is distinguished from the former by the much greater development of the second ambulatory legs and the structure of the outer [third] maxillipedes, whose merus [fourth] joint is elongated and

narrowed at its summit, where it is articulated with the next joint, and from the latter by the well-formed orbits and the entire absence of rudimentary fifth legs.' Those who are always sceptically inquiring for links in the chain of evolution and for the fine gradations which the transmutation of species postulates, may be invited to observe in this family the genus *Pinnixa*, White, in which the fifth legs are often short, the genus *Amorphŏpus*, in which they are rudimentary, and lastly *Thaumastoplax* and *Hexapus*, from which they have vanished altogether.

Some curious facts relating to the organs of vision in certain members of this tribe are worthy of mention. In the family Ocypodidæ the genus *Bathyplax*, A. Milne-Edwards, 1880, contains but a single species. Specimens taken by the U.S.S. *Blake* from depths between four and five hundred fathoms were found to have the eye-stalks very short, almost immovable, and with the corneæ not developed. Accordingly the species was named *typhlus*, 'the blind.' But specimens taken from smaller depths by the *Challenger* agreed with the others in all respects except just this one, that they possessed small, distinct, terminal corneæ. As these specimens were obviously not blind, Mr. Miers named them 'var. *oculiferus*.' In regard to another genus, also but more doubtfully included in the Ocypodidæ, Professor Perrier cites the observation of A. Milne-Edwards, that in *Geryon tridens*, Kröyer, a species which descends to great depths, the eyes are brilliantly luminous.

CHAPTER VIII

TRIBE III.—OXYRRHYNCHA

The carapace is more or less narrowed anteriorly and usually rostrate, with the hepatic regions small, the branchial large. The epistome is generally large. The buccal frame is quadrate, with the anterior margin straight. There are nine pairs of branchiæ, with the efferent channels opening at the sides of the endostome. In this, as in the two preceding tribes, the afferent channels open behind the pterygostomian regions, in front of the base of the chelipeds. The first antennæ are longitudinally folded. The third maxillipeds have the fifth joint articulated at the apex or at the front inner angle of the fourth. The verges of the male are exserted through the bases of the last pair of walking legs.

This tribe of the 'sharp-snouted' crabs is divided into two legions, the Maiinea and Parthenopinea. It has been observed in many cases that the two halves of the large liver are not separate, but united by a median lobe. The nervous system is said to attain a higher degree of centralisation in this group of Crustacea than in any other, the ganglia of the trunk forming a single solid disk-like mass.

Legion 1.—*Maiinea.*

The basal joint of the second antennæ is well developed, inserted beneath the eyes, and usually occupies a great part of the infra-ocular space.

This legion contains three families, the Inachidæ, Maiidæ, and Periceridæ.

Family 1.—*Inachidæ.*

The eyes are non-retractile, or retractile against the sides of the carapace. In general the orbits are not de-

fined, but there is often a well-developed præocular and postocular spine. The basal joint of the second antennæ is generally slender, sometimes moderately enlarged. The carapace varies in shape, being subtriangular, or truncately triangular or subpyriform, rarely suborbicular. The rostrum is simple or bifid, sometimes very short. The chelipeds never have the fingers excavate at the tips. The walking legs are sometimes very long. In both sexes the number of distinct segments of the pleon varies from four to seven.

To this family belong nearly forty genera, three of which are included in the British fauna.

Macropodia, Leach, 1814, meaning 'long-foot,' had been already called *Macrŏpus* by Latreille, but that form of the name was preoccupied. By Lamarck in 1818 it was named *Stenorynchus*, 'narrow-snout,' a very appropriate name but without any title to supersede the earlier *Macropodia* of Leach. Just as the title of the tribe Oxyrhyncha ought in accordance with its Greek original to be spelt Oxyrrhyncha, so should *Stenorynchus* have been spelt *Stenorrhynchus*. Part of this correction has been adopted in the commonly used form *Stenorhynchus*, and naturalists have been so much tickled with the pleasing sound that, instead of leaving the monopoly of it to the Crustacea, they have employed it also among beetles, reptiles, birds, and mammals. The British species *Macropodia rostratus* (Linn.) is described in Bell's History under the name *Stenorynchus Phalangium* (Pennant). The specific name given by Pennant alludes to the resemblance which these crabs with long thin legs bear to the Pycnogonids or Sea-spiders, and which has won for them the designation of spider-crabs. In spite of their long limbs they are a sluggish and slow-moving race, and in consequence are devoured in great numbers by other inhabitants of the sea. The fact that there are great numbers of them to be devoured shows that nature has not left them entirely without means of defence, of which some account will presently be given. *Macropodia longirostris* (Fabricius), which Bell calls *Stenorynchus tenuirostris*

(Leach), is, like the preceding species, found both in British and Mediterranean waters, and is distinguished from the other species partly by the relatively greater length of the rostrum.

Achæus, Leach, 1815, is so near to *Macropodia* that 'it is in fact only distinguished from it by the absence of rostral spines; the rostrum in *Achæus* being composed merely of two small acute or subacute lobes.' Of ten species enumerated by Miers only the type, *Achæus Cranchii*, Leach, belongs to the waters of Europe and Great Britain.

Inăchus, Fabricius, 1798, as at present restricted, contained in 1886 only six species, and these known only from European seas and the Western North-Atlantic. Three of these species are found in British waters, namely, *Inachus dorsettensis* (Pennant), *Inachus dorynchus*, Leach, and *Inachus leptochirus*, Leach.

Leptopodia, Leach, 1815, has apparently but one species, *Leptopodia sagittaria* (Fabricius), with an extensive range in the warm waters of the Atlantic and of the West coast of America. Unlike the three preceding genera this has the rostrum not bifid, but simple. This beak is very long and serrate on the edges. The carapace is not spinous. The chelipeds in the male are rather slender and very elongate; the walking legs are very slender and extremely elongated, with the seventh joint stiliform. Next to this genus Leach placed one which he named *Pactōlus*, with the species *Pactolus Boscii*, founded on a single female specimen in the British Museum from some unknown locality. Fabricius, he says, seems to have described it as the other sex of his *Inachus sagittarius*. *Pactolus* has a body exactly like *Leptopodia*, but the legs are of moderate length, and of these the first three pairs have simple claws, while the last two pairs are didactyle, that is to say, chelate. In 1793 Fabricius said of his *sagittarius* that in one sex the feet were of moderate size and all chelate, in the other six times as long and simple. In 1798, without any distinction of sexes, he states that eight of the feet are unguiculate and the last four pre-

hensile, thus making six pairs of legs, with a structural arrangement as regards three of them that would be unique among the Brachyura. At each date the species is said to come from the Isle of Guadeloupe. Leach rightly perceived that error and confusion were lurking somewhere, if it should not rather be said that they are conspicuous on the face of the two discordant accounts. Milne-Edwards in 1837, though with a confession of great uncertainty, institutes for the single genus *Pactolus* the tribe of the Pactoliens, which he places among the Anomura. But soon after, in 1839, de Haan with great acuteness observed, '*Pactolus*, Leach, Zoological Miscellanies, vol. ii. tab. 68, seems to me to be made up of the thorax of a female *Leptopodia sagittaria*, to which the legs of some other animal have been united; for the thorax of *Pactolus*, just as also the rostrum and abdomen, agrees with the female *Leptopodia*. The unlikeness in colour between the legs and the thorax in the figure referred to at once reveals the deception. Never are two alien forms found, agreeing exactly in the thorax, yet so disagreeing in the legs.' The principle here enunciated is worth remembering, as in some parts of the world there are dealers who delight and find profit and have also great skill in fabricating monstrosities, sometimes such as have deceived the very elect.

Nearly related to *Inachus* is the gigantic *Macrocheira Kämpferi*, de Haan, 1839, of which mention has been earlier made. In Japanese it is called the insular crab.

Huenia is another genus of this family instituted by de Haan in 1839. The name refers to the acutely triangular form of the carapace, and is derived from the Greek word *ὕνις*, a ploughshare, a derivation which would have been hard to guess, had not de Haan obligingly mentioned it himself. At the foot of his plate 23 he names the figures '4. MAJA (Huenia) *elongata* n. 5. *id. variet.* 6. MAJA (Huenia) *heraldica* n.' But the species established in the text is *Maja (Huenia) proteus*. The double generic name results from the inconvenient practice, still sometimes followed, of splitting a genus up into sub-genera. Sub-genera, if they are worth anything, are pretty sure to

FIG. 5.—*Huenia proteus*, de Haan, adult male, with separate figure of the pleon.

FIG. 6.—*Huenia proteus*, de Haan, young male.

FIG. 7.—*Huenia proteus*, de Haan, female, with separate figures of the pleon in a sterilised and a healthy specimen.

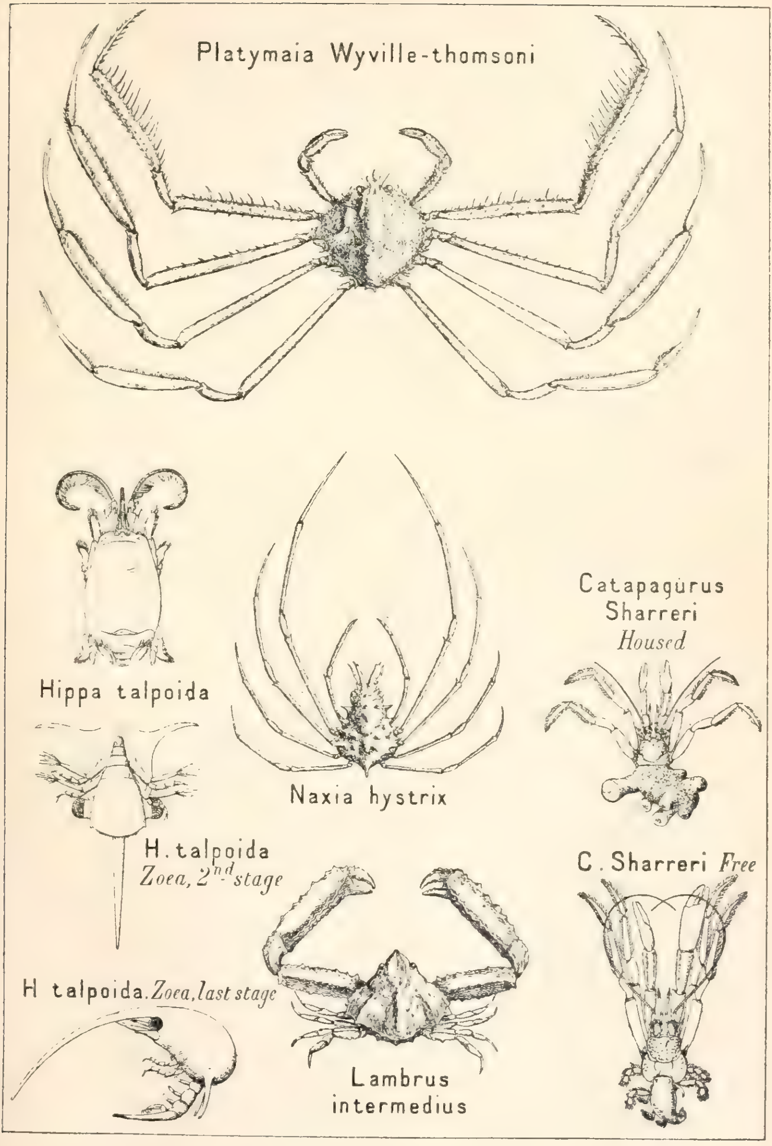
be regarded as genera later on, and might therefore just as well be called so at first. But for his change of the specific names de Haan had a reasonable though a rather singular excuse. After his plate had been engraved with the figures and names of two distinct species, based on the very great dissimilarity of the carapace in the male and female specimens at first available, he received a new series of specimens belonging to each form. These he found to agree in so many particulars that the protean form of the carapace no longer sufficed to separate them specifically, but had to be regarded as depending on the variations of age or sex. He here also observed that, as in several other Crustacea, there were what he supposed to be two forms of the female, the one ovigerous which he designates as genuine, the other sterile which he speaks of as spurious. In the present species he says that the pleon in the genuine females is of five segments, the fourth thick, very convex, with a longitudinal median impression, while in the spurious females it has seven segments, is lamellar and concave, with the fourth, fifth, and sixth segments dilated, the seventh narrower and truncate. The mystery of these so-called spurious females has been recently explained by Professor Giard. In studying the parasitic Crustacea, as well Isopoda as Rhizocephala, he was confronted by the statement which Rathke made in 1837, that of the many hundreds of *Bopyrus* which had passed through his hands he had never found one in any but a female *Palæmon*, and also by the statement which Fraisse made in 1877, that the males of *Inachus*, so far as he had observed, were never attacked by parasites, which he thought might be the result of the unsuitable shape of the narrow pleon in that sex.

The parasitic groups will be for after consideration, but it must here be mentioned that by careful investigation Professor Giard arrived at the very interesting result that the specimens of the higher Crustacea infested by the parasites are as a rule more or less completely sterilised, and that the secondary sexual characters are considerably modified, so that the males acquire to some extent the

appearance of the females, especially in the widening of the pleon, which is the first characteristic of sex that would generally be looked for. It follows, therefore, that among the specimens which in old times have been regarded as spurious females many spurious males were beyond doubt included. It is also worth remembering that when the shape of the pleon leaves the sex of a crab ambiguous, that may be taken as an indication that some curious species of parasitic crustacean is likely to be found in some part of the organism.

A large extension has been given to the family of the Inachidæ by recent voyages of deep-sea exploration, and in some instances species which, when first discovered only a few years ago, were naturally supposed to be rare, have since proved to be cosmopolitan. Thus the little *Lispognăthus Thomsoni* (Norman), a delicate species with long slender limbs, taken at a depth of two or three hundred fathoms in the Färö Channel, and first described in 1873, has since then been taken at much greater depths and at places so wide apart as the Straits of Gibraltar, the neighbourhood of the Cape of Good Hope, and of Sydney in Australia.

Ergasticus, A. Milne-Edwards, 1881, has two species —*Ergasticus Clouei*, A. Milne-Edwards, and *Ergasticus Naresii*, Miers. The latter was taken near the Admiralty Isles in the Pacific, and recalls the name of the honoured captain of the *Challenger*; the former was found in the Mediterranean and the Atlantic, and the name of the genus founded for it signifies 'a worker' in remembrance of the French ship, the *Travailleur*, by which the type-specimen was dredged. *Platymaia Wyville-thomsoni* (see Plate IV.), *Cyrtomaia Murrayi*, *Cyrtomaia Suhmi*, *Echinoplax Moseleyi*, represent new genera and species in this family instituted by Miers in 1886, in which the specific names have been chosen expressly to associate some of the finest of the Brachyura dredged by the *Challenger* with the names of its staff of naturalists. *Platymaia* and *Cyrtomaia* are also pointed out as of especial interest from their 'being Malayasian representatives of a section of the sub-family


Platymaia Wyville-thomsoni
Hippa talpoida
Naxia hystrix
Catapagurus Sharreri *Housed*
H. talpoida *Zoea, 2nd stage*
C. Sharreri *Free*
H talpoida. *Zoea, last stage*
Lambrus intermedius

Inachinæ, hitherto represented only by types from Eastern America.' Among those types the nearest to *Platymaia* is supposed to be *Euprognătha*, Stimpson, 1870. In regard to *Euprognatha rastellifera*, Professor S. I. Smith says: 'This is apparently by far the most abundant of all the Brachyura along our whole eastern coast south of Cape Cod—in the belt from 50 to 200 fathoms depth In the U.S. Fish Commission dredgings off Martha's Vineyard, many thousands of specimens were often taken at a single haul of the trawl.'

Family 2.—Maiidæ.

The eyes are retractile within the orbits, which are distinctly defined, but often more or less incomplete below or marked with open fissures in their upper and lower margins. The basal joint of the second antennæ is always more or less enlarged. The family includes about thirty genera, three of which are known in British localities.

Maia, Lamarck, 1801, is a genus well known rather to the south than the north of Great Britain in the species *Maia squinado* (Herbst). It is a large, eatable, and, in the south-west of England, an extremely abundant species. Its great inflated carapace, covered with prickles and fur, gives it a ready place in the memory when once it has been noticed. A pretty little amphipod, called *Isæa Montagui*, Milne-Edwards, with the sixth joint of its legs much widened, seems to have been specially adapted for ranging about this hirsute and prickly crab, the only place in which it is found. The convenience of the residence may be inferred from the fact, previously noticed, that from time to time a score of other species of Amphipoda find it their interest to occupy the same station. The crab, according to Herbst, is known as *Squinado* in Provence. In Cornwall it is called the Corwich, and Bell was told that in those parts several dozens could be had for sixpence. But even this does not give so ample an idea of its abundance as is conveyed by Olivi in his 'Adriatic Zoology' of a hundred years ago. He declares that in summer the crabs

are dispersed upon the shore, but that in winter the females collect on the deeper rocky ground in particular spots in a great crowd, and pile themselves up in such numbers that they form a sort of mound, which from the depth of eighty to a hundred feet ascends until the glimmer of it can be seen at the surface of the water, and that then the Istrian fishermen go out with two, four, or six boats, surround this living tower with their nets as easily as possible, and so make a speedy capture. Professor Stalio, in 1877, endorses this wonderful tale, except that in his account the boats employed are only two or four, and the instinct which leads these creatures to cling together and climb up one on another's back only produces a great pile of several feet in height. Yet anything much less than Olivi's submarine mountain of crabs would scarcely be visible from the surface at the depths which he mentions.

The Mediterranean possesses another closely allied species, *Maia verrucosa*, Milne-Edwards, smaller in size, and covered with warts or tubercles, instead of spines or prickles. This little crab led the way in quite recent years to some observations that throw a new light upon the mental powers of the Crustacea.

A great many of the Oxyrrhyncha have at all periods excited the surprise of collectors, when dealing for the first time with living specimens, by their often extreme untidiness. They are overgrown with algæ and ever so many kinds of sedentary animals. They are undoubtedly themselves slow-moving creatures, and it was not unnaturally supposed that these colonies with which they were encumbered and disfigured were at once a proof and a result of their extreme sluggishness. Dr. Graeffe had once occasion to carry into the aquarium at Trieste a specimen of *Maia verrucosa* which had been stripped of most of its vegetable costume. He happened to place it in the same vessel with a large mass of the polyp known as Dead Man's Fingers. The next day, to his astonishment, he found the whole back of the Spider-crab covered with pieces which had evidently been snicked out of the Alcyonium. To make sure, he kept watch, and at length had the sweet satis-

faction of seeing how the crab slowly stepped up to the polyp-mass, and with its claws tweaked off small points of the branches. At first it let them lie on the floor of the aquarium, but later on fished one of them up again with its claw, which it bent over the back of its carapace, and there among the fur it planted the fragment of the polyp with the severed surface downwards!

Further experiments showed that not only in the species of *Maia*, but also in those of *Pisa*, *Macropodia*, *Inachus*, and other Oxyrrhyncha, the foreign organisms were fastened to the crabs' bodies by the crabs themselves. That the object was concealment by the wearing of a mask was obvious, since the costuming was never at random, but always in strict agreement with the surroundings. Moreover, these marine zoologists know what sponges and polyps can be chopped up without causing mortality in the fragments. The pieces they plant are pieces that will live and thrive, and, as Dr. Graeffe observes, the keepers of aquaria have only to consult the crabs to learn what kinds of sea-animals will bear being thus transplanted piecemeal. For keeping on their living mask Dr. Graeffe found that the natural coats of these Crustacea were furnished with hairs varying in arrangement and shape in the different genera and species, some of the hairs being fish-hook-shaped, others clubbed, and others simply tapering, but all more or less serrate, the simple ones sufficing to detain a coating of slimy mud, while the others hold captive the living organisms.

Dr. Graeffe published his observations in 1882, but already in 1878 Dr. Eisig had reported of a species of *Inachus* that he had seen it plucking Hydroids and planting them on its spines and hairs, and Dr. C. Ph. Sluiter in 1880, when establishing the new species *Chorinus algatectus*, described its way of spitting little fragments of algæ on the strongly bent hooklets of its body and legs, to mask itself from its enemies and its prey. Additional details of great interest were published in 1889 by the Swedish naturalist Dr. Carl W. S. Aurivillius.

Hyas, Leach, 1813, comprises but few species, two of

which belong to Great Britain and are also extensively distributed in the North Atlantic. These are *Hyas araneus* (Linn.) and *Hyas coarctatus*, Leach. In a tiny specimen of the latter species, taken from off the carapace of the mother, small spines or tubercles are observable on both sides of each of the two divisions of the rostrum, on the outer side of the second antennæ, and on the eye-stalks. These minute characters do not reappear in the adult. The two species mentioned are very abundant on the coast of Sweden, and Aurivillius found that they were almost without exception dressed up either in pieces of different algæ (almost always Florideæ) or of shallow-water sponges, or with Hydroids, tubicolous Annelids, Polyzoa, Cirripedes, or Ascidians simple or compound. His experiments showed him that, if some of these settled rather by the crab's permission than its active interference, yet they had been originally under its control, while in most cases the colonists had been actually planted and forced at the will of the crustacean to occupy their several stations. He found, just as Mr. David Robertson of Cumbrae had done, that his specimens of *Hyas* were capable not only of dressing but of undressing themselves. Of the effectiveness of their disguises he had often had practical experience, when upon visiting his aquarium in the morning he was unable to find specimens which he had placed there overnight, and which he at first thought must have escaped. Close inspection and the help of a magnifying glass, however, would always show that they were present, but that they had so decked themselves out with the vegetables and animals around them as to lose all invidious prominence. By transplanting into an environment of sponges some that had clothed themselves in bright-coloured algæ, he ascertained how accurately they knew their business, for they laboriously picked off the gay colours, and stuck themselves over with fragments of sponge in their place.

The chelipeds of these crabs are adapted by length and by the flexibility of the joints to reach to the different parts of the body which require dressing up. The hooks and hairs which hold on the tags and patches have been already

considered. One curious point as to their distribution may be noticed. When the female is loaded with eggs, the basal segment or segments of the pleon are forced upwards so as to need concealment like the carapace. The result is, in some at least of the Oxyrrhyncha, that hooks for the attachment of foreign objects occur upon these segments in the females but not in the males.

While dressing themselves the crabs invariably bring each portion of their intended coat to their mouths as if

FIG. 8.—*Chorinus aculeatus*, Milne-Edwards [Aurivillius].

they were going to eat or at least to taste it. Aurivillius noticed that if a piece did not hold firm where the crab was seeking to plant it, recourse was had again to the mouth, and if the piece still proved intractable, it would be brought to the mouth a third time and then tried on a fresh spot. The object of this assiduous application to the mouth is, he thinks, that each piece may be well licked, a secretion from the mouth organs, especially the first pair of maxillipeds, bestowing the requisite adhesive

character. Considering the tolerably ruthless manner in which the crab gathers the constituents of its costume, one need not wonder at their needing a little emollient ointment. Under the circumstances their natural tendency to adhere might otherwise remain for some time dormant.

Chorinus aculeatus, Milne-Edwards, as depicted on the preceding page, is suggestive of a wardrobe provided with a truly enviable number of pegs. In regard to a closely related species, *Chorinus longispīna*, de Haan remarks that to the hooked setæ of the thorax and legs marine odds and ends adhere so closely that they can scarcely be removed without damaging the setæ. He is thinking only of man's rude handling, for, however remorseless such a crab may be towards its surroundings, we may feel assured that its deft fingers will do no violence to the well-appointed furniture of its own carapace.

Pisa, Leach, 1813, is open to the suspicion of being a synonym of *Arctopsis*, Lamarck, 1801. There are several species of this genus in various parts of the world. The two known in English and Irish waters occur also in the Mediterranean and have a considerable range north and south. These are *Pisa tetraodon* (Pennant) and the species which Bell calls *Pisa Gibbsii*, Leach, a name which must be wrong, whatever other is right. Miers with some hesitation adopts for it the name *Pisa* (*Arctopsis*) *tribŭlus* (Linn.).

Naxia, Milne-Edwards, 1834, is narrowly distinguished from *Pisa* by the accessory spinules of the two-horned rostrum. *Naxia hystrix*, Miers (see Plate IV.), was obtained by the *Challenger* at Amboina.

Lissa, Leach, 1815, is a genus apparently near to *Pisa*, but with a rostrum consisting of two truncate laminar horns side by side, which are somewhat wider at the extremity than at the base. It was formed for the Mediterranean species *Lissa chiragra* (Fabricius), which is deep red in colour, and has the legs so covered with protuberances that its specific name, meaning 'gout in the hand,' is not inappropriate, although it so happens that the hands

of the chelipeds are almost the only smooth part about it. It is said by Stalio to be sensitive to changes of temperature, and at any increase of cold to crouch closely in the crevices of the rocks, but as he also says that its habitat is at a depth of thirty to forty fathoms, it is not easy to understand how this valetudinarian shrinking has been ascertained. The crab is only about two inches long, and according to Herbst is commonly covered with worm-tubes, corals, algæ, and mud, to such an extent that it is scarcely to be recognised or to be taken for a living creature.

Chionœcētes, Kröyer, 1838, is a northern genus, with a name meaning 'the snow-dweller,' founded for the Greenland species *Chionœcetes opilio*, which, according to Professor S. I. Smith, is taken rarely in the deep water off the New England coast. 'It is,' he says, 'one of the largest arctic crabs, and occasionally attains gigantic proportions.' In the largest specimen that he examined the span of the walking-legs was two feet eight inches. The specimen figured by Kröyer in Gaimard's voyages was, he says, even somewhat larger, but though the figure occupies the whole extent of the folio plate, I do not find that even with the second pair of legs which are the longest or with the third pair which are inserted at the broadest part of the carapace could it span more than twenty-eight inches.

Antilibinia Smithii, M'Leay, is a South African species which Krauss observed in its native haunts on the perpendicular wave-lashed cliffs of the headland at Natal. Its legs are powerful and have the terminal joint bent into a strong hook by which the crab can fasten on to the pores of the rock. Its body is rounded off and has a very hard horny shell well adapted to resist the continual beating upon it of the surf. Among the bright and dark green algæ, and coloured like them, it sits almost completely motionless and lets its food be floated to it by the ever-moving sea. When Krauss wished to take some specimens away from their dangerous position, they clung so tight that he had to use considerable force to disengage them, and was in consequence several times overtaken by the returning waves before he could effect his purpose. It

is pleasant to see how creatures comparatively feeble may sometimes find security in stations the most unpromising and the most exposed. The whole tribe of the Oxyrrhyncha are indeed often placed at the head of all the Crustacea in honour of the ready wit and resource which so many of them display.

Scyramathia Carpenteri (Norman) is a remarkable crab first observed on the *Porcupine* expedition in the Channel between the Färö and Shetland Isles. It was afterwards obtained abundantly by the *Travailleur* from great depths in the Bay of Biscay, and again the Norwegian North-Atlantic expedition trawled it from a depth of 220 fathoms about twenty miles off the west coast of Norway.

According to the description of it by Professor Sars, 'the whole surface of the body is invested, as it were, with a dense, felt-like covering, which, on closer inspection, is found to consist of two different kinds of cutaneous appendages. Innermost, crowded together, are observed numerous small tuberculiform excrescences, which, at the first glance, may be readily taken for granulations on the skeleton of the skin, but, after a closer examination, are seen to be of a totally different character, since they have not only a soft consistence, but admit of being scraped off with the greatest facility. On treating these protuberances with a solution of potash, they are found to be true cutaneous vesicles or capsules, that, with a broad basis, are attached to the skeleton of the skin and supported in the middle by a slender chitinous-like rod, of which the point projects more or less distinctly forward from the top. Between these peculiar cutaneous appendages, and projecting considerably beyond them, are short and comparatively stiff hairs, somewhat unguiform at the extremity, and crowded together, in particular on the anterior part of the dorsal surface of the carapace, which thus acquires a velvety appearance.'

The rostrum also is highly characteristic. It is divided from the base into two straight, strongly divergent, branches, about half as long as the carapace. They are cylindrical at the base, but taper gradually to a dagger-like point, and

are thickly covered with hair. There is, according to Sars, a possibility, which, however, S. I. Smith thinks an improbability, that the species may be the same as one earlier but all too briefly described by Stimpson, from the coast of Florida, under the name *Scyra umbonata*. The specimen taken by the *Porcupine* was first described as *Amathia Carpenteri*, but the genus *Amathia*, Roux, has a pre-occupied name which has in consequence since been changed, by S. I. Smith, to *Anamathia*, and Professor A. Milne-Edwards discovered that the species *Carpenteri* could not be included in that genus. At the same time he noticed its likeness to Stimpson's species above mentioned, and framed for it the new genus *Scyramathia*. From the foregoing remarks it will easily be understood what suggested the composition of this generic name, but it must not be forgotten that *Scyramathia* belongs to the family Maiidæ, whereas *Anamathia* stands in the previously described Inachidæ, and *Scyra* (though to the exclusion of Stimpson's species *umbonata*) is a genus belonging to the next family, the Periceridæ.

Family 3.—Periceridæ.

The eyes are retractile within the small circular and well-defined orbits, which are not incomplete as in the Maiidæ. The basal joint of the second antennæ is well developed, and constitutes a great part of the inferior wall of the orbit, the joint being in general much enlarged.

The family contains about twenty genera.

Pericĕra, Latreille, 1829, of which the type is *Pericera cornudo* (Herbst), 1804, has been despoiled of many of its species by Miers, who has transferred them to *Macrocœlōma*, a new genus which he instituted in 1879. Of the species *Macrocœloma trispinosa* (Latreille) Mr. Ives says that Yucatan specimens when alive are of a bright scarlet colour. In the *Challenger* species, *Macrocœloma concăva*, Miers, from Bahia and Fernando Noronha, the body and limbs are covered with a short close pubescence and with some longer curled hairs. Its colour in spirit is

yellowish-brown, but this is little or no guide to what its colour may have been when living. The specific names in this genus ought to have either masculine or else neuter terminations, but many naturalists seem to suppose that any generic name ending in -a is a feminine form, which is far from being the fact.

In this family the genus *Libinia*, Leach, 1815, contains several species, and *Mithrax* (Leach), Latreille, 1817, a very large group. Of *Libinia emarginata*, Leach, Miss Mary Rathbun, in her recent revision of the Periceridæ, says that in Long Island Sound occasionally this species by its numbers 'so interferes with the steam oyster dredgers that work is abandoned until the crabs (which are known to the oystermen as "spiders") have passed over.'

Legion 2.—*Parthenopinea.*

The basal (or true second) joint of the second antennæ is very small and embedded with the next joint in the narrow gap between the 'front' and the inner orbital angle, the infraocular space being mainly occupied by the inferior wall of the orbit.

Family 4.—*Parthenopidæ.*

The eyes are usually retractile within the small circular and well-defined orbits; the lower wall of the orbit is continued to within a very short distance of the 'front.' The second antennæ are very slender; the basal joint does not as in the Periceridæ constitute a great part of the inferior orbital margin, but is very small, seldom reaching the 'front,' and with the next joint occupies the narrow gap intervening between the 'front' and the inner angle of the orbit. (In *Ceratocarcinus* the antennæ are completely excluded from the orbits.)

Some fifteen or twenty genera are reckoned in this family, of which only one is known in the waters of Great Britain.

Eurynŏme, Leach, 1814, has not yet received many

additions to the type species *Eurynome aspera* (Pennant), for though the names *scutellata* and *boletifera* have been given to forms taken in the Mediterranean, it is probable that they are not distinct from, or at most are only varieties of, the species found on the British coasts. It is, as might be guessed from the names, a species rough with warts or tubercles. The walking-legs are short, but the chelipeds in the male are elongate, being nearly twice the length of the body according to Bell, but according to Leach three times its length. *Eurynome tenuicornis*, Malm, from Bohuslän, Gullmarsfjord, is there found together with *Eurynome aspera*.

Parthenōpe, Fabricius, 1798, has in its type species, *Parthenope horrida* (Linn.), an animal of truly remarkable appearance. It is recorded from the West and East Indies, and has been called the great Warty Crab or stigmatised as the Lazy Crab. Its carapace is pentagonal, broader than long. While this and the legs are covered with warts and spines, the pleon is said to be full of pits, almost as if eaten through. The chelipeds are large and long. From the picture of it given by Herbst one might suppose that it was intended to look like a piece of light-red sandstone overgrown here and there with green algæ.

Lambrus, Leach, 1815, unlike the two preceding genera, suffers from no paucity of species. So numerous indeed are they that in 1878 Professor A. Milne-Edwards deemed it expedient to subdivide *Lambrus* into ten genera, including in the number *Solenolambrus*, Stimpson, and *Mesorhœa*, Stimpson. The species are distributed over all the warmer seas of the world, and some occur in the Mediterranean. Of these *Lambrus macrochēlos* (Herbst), meaning the *Lambrus* with long chelipeds, justifies its name, but almost puts its body out of countenance, seeing that the arms in question are nearly four times as long as either the length or breadth of the carapace. In *Lambrus intermedius*, Miers (see Plate IV.), from the Corean Seas and Torres Strait, the disproportion between legs and trunk is less exaggerated. In the genus at large it is remarked that, apart from larval metamorphoses, so many variations

of form are undergone during progress to the adult condition, that, without a considerable series of specimens, young and old of the same species must often almost inevitably be considered as distinct.

Heterocrypta, Stimpson, 1871, contains but three species, and those of small size but singular appearance. One of these, *Heterocrypta Maltzani*, Miers, which has been taken at Goree Island, at the Azores, and off Senegambia, is also an ornament of the Mediterranean, having been taken by the *Travailleur* at a depth of about 250 fathoms off Toulon. The Mediterranean form was at first named *Heterocrypta Marionis*, after the distinguished French zoologist, but it has since been found to be the same species as *Heterocrypta Maltzani*.

CHAPTER IX

TRIBE IV.—OXYSTOMATA

THE carapace is convex or depressed, with the antero-lateral margins arcuate or orbiculate; or even subglobose; or more or less oblong, with subparallel or slightly convergent margins (Dorippidæ). The epistome is very much reduced or rudimentary. The buccal frame is more or less triangular, nearly always produced and narrowed forwards with the margins anteriorly convergent. The afferent channels to the branchiæ open either behind the pterygostomian regions and in front of the chelipeds, or, more rarely, at the antero-lateral angles of the palate (Leucosiidæ). The efferent channels open at the middle of the endostome which is produced forwards. There are six to nine pairs of branchiæ. The first antennæ fold longitudinally or obliquely. The third maxillipeds have the fifth joint articulated at the inner or the outer front angle or at the apex of the fourth, beneath which it is often concealed. The verges of the male are exserted either from the surface of the sternal plastron or more usually from the bases of the fifth pair of legs, which are either adapted for walking or for swimming, or are feeble and raised upon the dorsal surface of the carapace.

It is the narrowing anteriorly of the buccal frame or 'mouth-cavity' that gives the name of 'sharp-mouths' to this tribe, which is divided into four families, the Calappidæ, Matutidæ, Leucosiidæ, and Dorippidæ.

Family 1.—*Calappidæ.*

The afferent channels to the branchiæ open behind the pterygostomian regions and in front of the chelipeds.

The third maxillipeds have the fifth and following joints not wholly concealed by the fourth joint. The verges of the male are exserted from the bases of the fifth pair of legs.

There are about ten genera included in this family.

Calappa, Fabricius, 1798, contains some fifteen species, which are not a little remarkable in appearance. This is partly due to the form of the carapace, much narrowed in front where the short-stalked eyes twinkle cunningly, but widened behind with shield-like expansions over the bases of the legs. More singular, however, is the development of the chelipeds, which have a very flat crested hand of great size, yet the whole limb withal so arranged that the pair can be concealed beneath the body to which in that position they might be said to supply an operculum or incomplete ventral carapace. Of *Calappa granulata* (Linn.) Stalio says that, when it is compelled by fear of some enemy or by the force of the waves to leave its crevice in the rock, it draws together its walking-legs under the expanded parts of the carapace, makes its chelipeds meet, and, being thus reduced to the shape of a ball, launches itself into the deep. Unfortunately for it, the scouring of the waves often throws it up on to the shore, where continuous rolling upon the pebbles puts an end to its existence. This is a waste of what would otherwise form an agreeable morsel. It may be eaten with a good conscience, since it is itself very voracious, and when in pursuit of prey not to be intimidated. Judging from the contents of the stomachs of various Crustacea, de Haan was able to decide that *Calappa*, *Matuta*, and *Dorippe* feed on other Brachyura, *Leucosia* on species of *Palæmon*, *Ranina* on fishes and starfish. *Calappa gallus* (Herbst) is common to the Atlantic and the Pacific. The crested claws here carry to an almost comical extreme the resemblance to the head of a cock, which they exhibit more or less throughout this genus. *Calappa depressa*, Miers (see Plate II.), from the South Australian coast, is one of the smaller species and a recent contribution to science.

Paracyclois, Miers, 1886, is a genus in which the chelipeds and walking-legs agree with those in *Calappa* and

Cryptosōma, and it is considered to connect *Cryptosoma*, Brullé, and *Platymēra*, Milne-Edwards, with *Calappa* through such forms as the above-mentioned *Calappa gallus* (Herbst), but *Paracyclois* is distinguished from the first two of these genera by the absence of any lateral spine on the margin of the carapace, and the broader basal joint of the second antennæ. 'and from *Calappa* by the absence of the clypeiform prolongations of the carapace, which are represented by a slight protuberance of the postero-lateral margins in *Paracyclois*, which protuberance bears several strong spines.' The type species of this curious genus, *Paracyclois Milne-Edwardsii*, Miers, was dredged north of the Admiralty Isles from a depth of 150 fathoms.

Cryptosōma cristatum, Brullé, was depicted in Webb and Berthelot's 'Hist. Nat. des Iles Canaries,' and the genus was instituted at page 16 of that work, for which Miers gives the dates 1836–1844. Milne-Edwards in 1837, while his own pages were passing through the press, refers to Brullé's genus and species as about to be published. In the same year, 1837, de Haan published a new genus and species, *Cycloës granulosa*, from Japan. In 1841 he states that Brullé's species is clearly the same as this, and in 1849 he repeats the remark as an example of wide distribution, the very same crab being found at the Canaries and in the waters of Japan. But he retains the name *Cycloës*, being evidently, and perhaps rightly, under the impression that it had priority over *Cryptosoma*.

Orithyia, Fabricius, 1798, is strongly distinguished from the other genera of this family by the natatorial character of the last three pairs of legs, which have an ovate terminal joint, as in the Portunidæ. The three preceding pairs of legs have also the terminal joints flattened, and the others more or less compressed, as is usual in species apt for swimming. There appears to be only one species, found in the Chinese Sea, and called *bimaculatus* by Herbst in 1790, and *mammillaris* by Fabricius in 1793. Herbst, whose specific name must prevail, says that 'without dispute this crab is one of the most beautiful and most rare.'

Family 2.—Matutidæ

The characters are the same as in the Calappidæ, except that the third maxillipeds have the three terminal joints concealed beneath the triangular acute fourth joint.

The family contains four genera.

Matūta, Fabricius, 1798, is regarded as the genus among the Brachyura in which the adaptation for swimming attains its highest development. In the last pair of legs the oval terminal joint is supplemented by a very broad expansion of the preceding joint. Moreover, the other three pairs of legs are natatorial, having broad flattened joints, in particular the pair next the chelipeds evidently forming paddles of great power. Nevertheless, none of these limbs are fringed with hairs, the ordinary armature of swimming legs. The sufficient reason assigned for this is that the crab's safety often depends upon the extraordinary rapidity with which it can bury itself in the wet sand. Its flattened joints have sharp points and edges, with the digging powers of which any fringe of fur would seriously interfere. As it is, they can slip themselves under the sand in a moment, and before the troubled water has cleared over their departing footsteps the traces of them are smoothed and lost. Yet sometimes, it is said, their movements may be perceived under the feet of a person walking along the shore. Among the Japanese specimens of *Matuta victor*, Fabricius, de Haan observed some of what he calls 'spurious females,' but he mentions no peculiarities in them except their smaller size. If Paulson's identification be right, the name of this species should become *Matuta lunaris* (Forskål.)

Hepătus, Latreille, 1806, has, according to de Haan, the third joint much shorter than the fourth in the third maxillipeds, whereas in *Matuta* those two joints are equal in length. *Hepatus princeps* (Herbst) appears to be the proper name of the type species, which occurs both in the East and West Indies. This genus, and with it *Osachīla*,

Stimpson, and *Actæomorpha*, Miers, are distinguished from *Matuta* by having the terminal joints of the legs adapted, not for swimming, but for walking. *Osachila* and *Actæomorpha* are, according to the author of the latter genus, perhaps identical.

Family 3.—*Leucosiidæ*.

The afferent channels to the branchiæ open at the antero-lateral angles of the endostome and not behind the pterygostomian regions. The third maxillipeds have the three terminal joints wholly concealed by the triangular fourth joint. The verges of the male are exserted from the sternal plastron.

In this family twenty-nine genera are accepted by Miers in 1886. One of them is included in the fauna of Great Britain.

Leucosia, Fabricius, 1798, contains numerous species, which occur in the littoral and shallow waters of the Indo-Pacific region. They are often remarkable for the beauty of their colouring, testimony to which is borne in the names of the species, *Leucosia splendida*, Haswell, and *Leucosia pulcherrima*, Miers. They have the frontal region of the carapace narrowed and produced anteriorly, and in front of and above the bases of the chelipeds there is a pit defined by a series of granules. This, which is continued as a shallow excavation beneath the postero-lateral margins of the carapace, has received the name of the thoracic sinus. The walking-legs are small, successively shorter from the front to the rear. The pleon of the male in some species has all the segments united except the first and last, in others the third coalesced with the fourth, and the fifth with the sixth. A figure of *Leucosia australiensis*, Miers, is given on Plate II. The type species, *scabriuscula*, Fabricius, has been transferred to the next genus.

Philÿra, Leach, 1817, is a genus nearly allied to *Leucosia*, with a similar range, and also containing several species. But, among other distinctions, the 'front' is

broader and not at all prominent, and there is no 'thoracic sinus.' *Philyra pisum*, de Haan, is said to be infested,

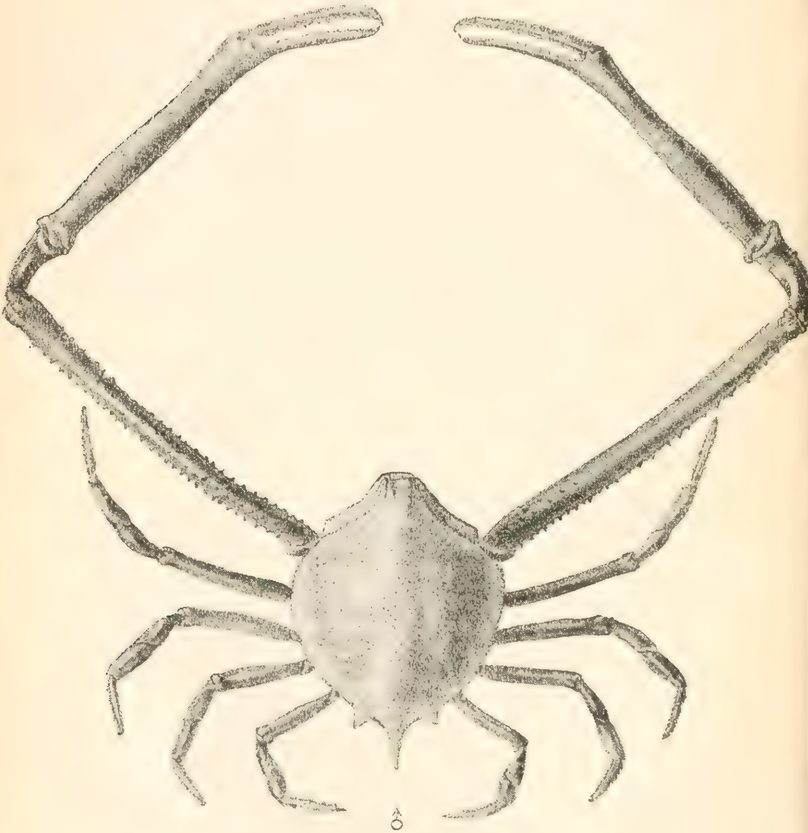


FIG. 9.—*Myra fugax* (Fabricius) [de Haan].

like *Leander squilla* and *Leander serratus*, by a *Bopyrus*, making the sides of the crab bulbous. De Haan remarks that he never saw the *Bopyrus* in true females, and that in males they occupy the right side, in spurious females

the left side, of the crab. The parasite referred to would no doubt now stand under some other generic name.

Myra, Leach, 1817, is another genus of common occurrence throughout the Indo-Pacific region, of which the species *Myra fugax* (Fabricius) has been frequently renamed. It is remarkable for the great length which the slender chelipeds sometimes attain, and which have caused the Japanese to call it the long-handed crab.

Ebalia, Leach, 1817, has an extremely extended range, and includes numerous species, among which several occur in European seas, and four of them in the waters of Great Britain. These four are *Ebalia tuberosa* (Pennant), *Ebalia tumefacta* (Montagu), *Ebalia Cranchii*, Leach, and *Ebalia nux*, Norman. It is curious that Bell, in his 'History of British Stalk-eyed Crustacea,' should have thought it right to follow Leach in calling the first two of these respectively *Ebalia Pennantii* and *Ebalia Bryerii*, while he relegated the earlier names to the synonymy. The resemblance which these little creatures, with their legs all tucked up, assume to a rugged little fragment of stone has been already mentioned. Comparing *Ebalia* with a genus *Phlyxia* instituted by Bell in 1855, Mr. Miers says:—'The genera *Ebalia* and *Phlyxia* are now connected by so many intermediate species, that not one of the distinctive characters mentioned by Bell can be regarded as constant. I propose, therefore, to unite these genera, but to separate the species under two primary sections or sub-genera (for which the names *Ebalia* and *Phlyxia* may conveniently be retained) as follows:—

'I. Front slightly concave or truncated, not quadridentated (*Ebalia*).' This is followed by a list of twenty-six species.

'II. Front with four distinct (usually tuberculiform) lobes or teeth, including the tooth at the interior angle of the orbit (*Phlyxia*).' This is followed by a list of seven species, in regard to which it is pointed out that all are restricted to Australia. The convenience of having a generic name to indicate so small a mark of separation may well be questioned, but the inconvenience of the sub-

generic name scarcely admits of question, especially when it leads to the possibility of a creature being called

'*Ebalia (Phlyxia) undecimspinosa* (Kinahan), var. *orbicularis*,' a name which is even then incomplete without the addition of the names (Haswell) Miers, to show that Mr. Miers has made Haswell's *Phlyxia orbicularis* a variety of Kinahan's *Ebalia undecimspinosa*.

Ixa, Leach, 1815, has perhaps, according to Mr. Miers, only one species, though five have been named. This one is the *Ixa cylindrus* (Fabricius), called *Ixa canaliculata* by Leach. It is widely distributed in the Indo-Pacific region, and has a very remarkably shaped carapace, transversely rhomboidal or somewhat elliptical, and prolonged at either side into a cylindrical lobe, which is often as long as the width of the main portion of the carapace.

Oreophŏrus, Rüppell, 1830, 'the hill-bearer,' and *Spelæophorus*, A. Milne-Edwards, 1866, 'the cave-bearer,' have names referring to the prominences and depressions in the carapace.

Family 4.—*Dorippidæ*.

The afferent channels to the branchiæ open behind the pterygostomian regions, and in front of the chelipeds. The three terminal joints of the third maxillipeds are not concealed by the fourth joint. The last pair or last two pairs of legs are short and feeble, and raised on the dorsal surface of the carapace. The verges of the male are exserted from the sternal plastron.

The family includes eight or nine genera, the position of *Cyclodorippe*, A. Milne-Edwards, being rather doubtful, since in it there are no afferent openings to the branchiæ in front of the chelipeds.

Dorippe, Fabricius, 1798, has a wide range, and includes several species. One of them, *Dorippe facchino* (Herbst), is found both in the Mediterranean and at Hong Kong. The first two pairs of walking-legs are long, and enable the creature to run fast. The two following pairs are very slender and short. To account for their dorsal position various reasons have been suggested. Herbst

says that the crab can run either way up. Another view is that these hind legs lift foreign objects on to the carapace,

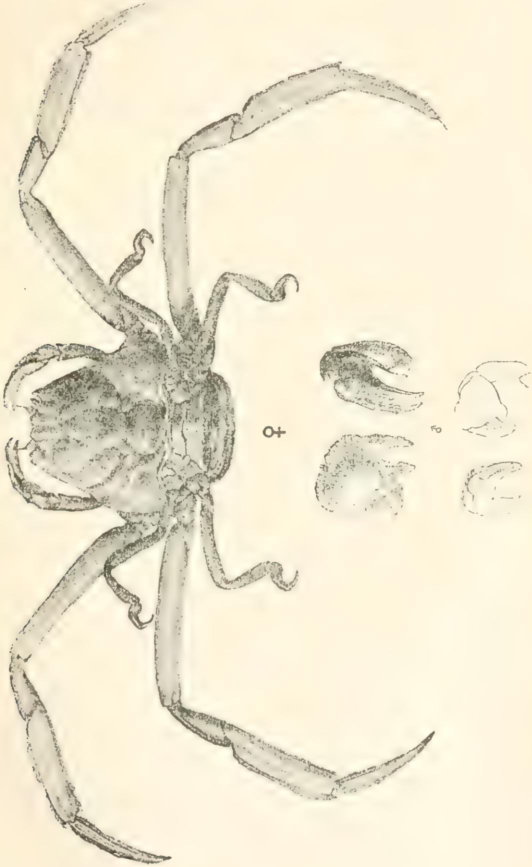


Fig. 10.—*Dorippe japonica*, von Siebold, a female specimen, with separate figures, showing the chelipeds of the male from the inner and outer sides, the left cheliped being the stouter [de Haan].

and a third that they help to repel animals that might otherwise tread on the crab's back. The specific name which Herbst gave it means a knave, and is its trivial name

among the Italians, in evident allusion to the resemblance it bears to a comic mask. Similarly, *Dorippe dorsipes* (Linn.) is not inappropriately named by the Japanese 'the demon-faced crab.' *Dorippe japonica*, von Siebold, represented on the preceding page, is closely allied to Herbst's *Dorippe facchino.*

Ethūsa, Roux, 1828, unlike *Dorippe*, which usually has the carapace broader than long, in general has the carapace much longer than broad. Miers notices that the species of this genus are the forms which evince the greatest degree of degradation from the Brachyuran type. In other words, they make the nearest approach to the next tribe, which in Mr. Miers' work is not included among the Brachyura. *Ethusa mascarone*, Roux, is a Mediterranean species. *Ethusĭna*, S. I. Smith, 1884, is closely allied to *Ethusa*, but distinguished by the form of the first antennæ, the basal joints of which are very large and swollen, occupying the whole width of the 'front,' and crowding back the eyes and second antennæ into an almost transverse position. The type species, *Ethusina abyssicŏla*, Smith, was dredged off the East Coast of the United States at a depth of about 1,500 fathoms, the members of this genus and *Ethusa* being those which descend to greater depths in the ocean than any of the Brachyura which we have been hitherto discussing. The species *Ethusa granulata*, Norman, has been transferred to a separate genus, *Cymonŏmus*, by Professor A. Milne-Edwards.

Cymopolia, Roux, 1828, has for its type species, *Cymopolia Caronii*, Roux, from the Mediterranean, but it includes twelve species in all, of which eight have been recently instituted by Professor A. Milne-Edwards from dredgings in the Gulf of Mexico and Straits of Florida. De Haan considered that it ought to stand among the Maiacea, but his opinion has not been followed.

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CHAPTER X

TRIBE V.—ANOMALA

THE sternal plastron or breastplate is wide. The branchiæ lie obliquely, and may attain the number of fourteen pairs. The vulvæ open not on the breastplate, but in the bases of the third pair of legs.

This tribe of Anomalous Brachyura has long been considered a division of a separate sub-order called the Anomura, meaning Stalk-eyed Crustaceans 'with unsymmetrical tails.' To this division the name Apterūra was given, to distinguish it from another division called Pterygūra. The first name signifies those that have unwinged tails, the second those that have winged tails. The wings referred to are formed by the appendages of the sixth segment of the pleon, which in the Pterygura are expanded on either side of the telson, but which in the Apterura are not developed By the transfer of the latter division to the Brachyura its old name becomes unsuitable, since all of that sub-order are apterurous. It contains two legions, the Drominea and Ranininea.

Legion 1.—*Drominea.*

The carapace is subglobose or subquadrate, the 'front' narrow. The third maxillipeds have the third and fourth joints subquadrangular. The lateral apodemata[1] of the trunk are united in a common centre, forming a sternal canal. The last pair, and often the last two

[1] The *apodemata* or apodemes are processes formed by an infolding of the cuticle and extending inwards to give surfaces of attachment for the muscles and to assist in protecting the internal organs

pairs of legs, are subdorsal in position and of small size. The pleon folds under the trunk. In the female it has five pairs of appendages, of which the first is rudimentary.

This legion is divided into two families, the Dromidæ and Homolidæ, the characters of which are here accepted as laid down in Professor J. R. Henderson's Report on the Anomura of the *Challenger*.

Family 1.—*Dromidæ*.

The carapace is subglobular, rarely flattened. The eyes are retractile into well-defined orbits. The first antennæ fold in special fossettes. The fifth and usually also the fourth pair of legs are short, subdorsal in position, and in general prehensile. The vasa deferentia of the male pass through the bases of the fifth pair of legs and form tubular prolongations.

The family contains some ten genera, one of which is British.

The species, Dr. Henderson says, inhabit shallow water and moderate depths. The majority protect the body by an ascidian, a sponge, or by one of the shells of a bivalve mollusc. Milne-Edwards says that of the fourteen pairs of branchiæ[1] the last two spring from the last two segments of the trunk, which in the Brachyura in general never carry any. He regards two little lateral pieces intercalated between the sixth and seventh segments of the pleon in *Dromia* as rudiments of the appendages of the sixth segment, but that may be regarded rather as a pious opinion than an established fact.

Dromia, Fabricius, 1798, almost monopolised the family until it was subdivided by Stimpson into six genera in 1858, this subdivision being grounded chiefly on the disposition of the sternal sulci in the female.[2] In

[1] Branchiæ are called pleurobranchiæ when attached to the pleura or sides of the segment, podobranchiæ when attached to the first joint of the limb, arthrobranchiæ when they spring from the interarticular membrane between the segment and the limb.

[2] For the structure of these sulci and the correspondence of the appendages on the pleon of the male, see the account in de Haan, *Fauna Japonica, Crustacea*, p. 105.

Dromia, as restricted by Stimpson, these sulci are 'not approximated, only produced as far as the segment which bears the second pair of legs.' The carapace in this genus is subglobose and usually hairy. Fabricius, in describing *Dromia Rumphii* as the type species from the East Indies, says that it hides in the sand holding the valve of a shell over its body with its hind feet, and so lies in wait for little fishes. It was called *Cancer dormia* by Linnæus, perhaps in allusion to the widely prevailing idea that it is poisonous and narcotic. Herbst, for this reason, improved the Linnæan name into *Cancer dormitator*, meaning the crab that sends you to sleep, for he rejected a previous improvement of the name into *dromia*, on the ground that to call it the running crab was to name it quite in contradiction to its habits. In spite of, or in ignorance of, this criticism, Fabricius converted the specific name *dromia* into the name of the genus, which holds its ground notwithstanding the inappropriateness to a creature of especially sluggish habits.

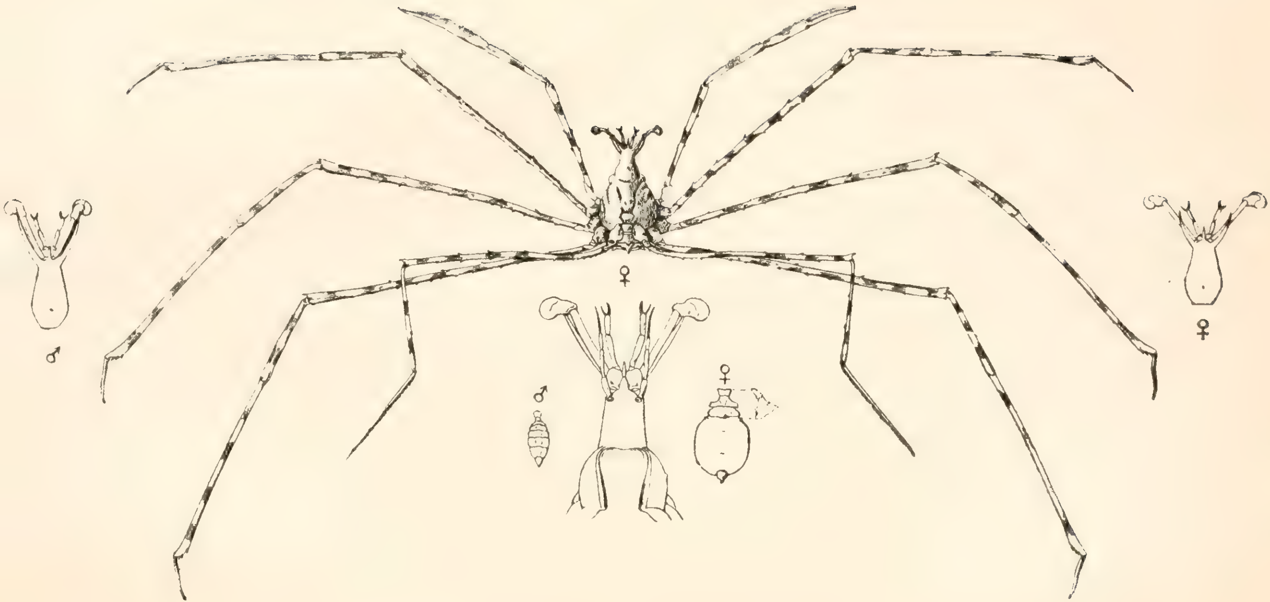
Dromia vulgaris, Milne-Edwards, is sometimes taken in English waters. It is very common in the Adriatic, and according to Stalio the ancients were quite mistaken in attributing to it a poisonous character. Herbst seems to have thought the *Dromia Rumphii* 'by the hand of nature marked, quoted and signed, to do a deed of shame,' for, after describing its rough, brown, furry coat, its short, thick legs, and the last pair armed with sharp-pointed claw like a scorpion's tail, he adds that 'everything contributes to give this crab a repulsive and horrible appearance, perhaps to scare men from eating it, since it is very poisonous.' He subsequently noticed that when stripped of its fur it lost its grimness of aspect.

The habit of concealment that runs through this family is referred to in several of the generic names, as in *Cryptodromia*, Stimpson, 1858, the concealed Dromia, in *Hypoconcha*, Guérin Méneville, 1854, the crab under a shell, in *Conchœcĕtes*, Stimpson, 1858, the shell-dweller. Among the Crustacea collected a few years back by Surgeon-Major Archer on the sand and mud banks north

of Singapore, there were, he says, 'two species with curved hooks on their hindmost claws, by means of which they hold on to a mangrove-leaf or a dead valve of a shell which conceals the animal from view; these leaves and dead valves may be seen apparently walking along on the shore.' The species in question are supposed by Mr. A. O. Walker, in his account of the collection, to be *Dorippe sima*, Milne-Edwards, *Dorippe astuta*, Fabricius, and *Conchœcetes conchifera* (Haswell). Bell says of numerous young specimens of *Dromia vulgaris*, which he had received from Sicily, that every one had the carapace entirely covered with a sponge, which concealed the two hinder pairs of legs, and rendered them immovable. In *Cryptodromia lateralis* (Gray), a species which ranges from Australia and New Zealand to the coasts of Japan, the animal is said to have almost invariably a sponge fixed on the carapace, covering it completely. *Hypoconcha sabulosa* (Herbst), besides protecting itself with the shell of a Lamellibranch mollusc, perhaps wears an inner vest of sand, for the museum specimen which Herbst examined was, he says, more like a lump of sand than a crab, and the carapace he found was extremely thin, delicate, and almost membranaceous. In this genus the sternal sulci of the female are widely separate, 'each terminating in a tubercle opposite the basal joint of the second ambulatory leg.' The terminal joints of the last two pairs of legs are described as Y-shaped, but it must be remembered that the two arms of the Y are by no means equal.

Petalomēra pulchra, Miers, a Melanesian species of very small size, may be noticed as one member of this family which has obtained the epithet of beautiful, although in general figure it is not so very remote from the *Dromia* of which Herbst speaks so disrespectfully.

Dynomene, Latreille, 1825, is distinguished from the rest of the family by having only the fifth pair of legs subdorsal in position.



Latreillia valida, de Haan

Family 2.—Homolidæ.

The carapace is quadrangular or subtriangular. The eye-stalks are usually slender and very long, the orbits very incomplete. The first antennæ are not retractile into special fossettes. The last pair of legs are small, prehensile, subdorsal in position.

The family may include five genera. The species extend to moderate depths.

Dicranodromia, A. Milne-Edwards, 1880, is what is called an inosculant genus. By the character of the last two pairs of legs it should belong to the Dromidæ, but the defective orbits and the want of fossettes for the first antennæ place it among the Homolidæ.

Homŏla, Leach, 1815, has the carapace quadrilateral, of greater length than breadth. The eye-stalks have a long slender basal part and a shorter dilated corneal portion. The chelipeds are of moderate size, the three following pairs of limbs are long and flattened, while the last pair are short and subchelate. *Homola barbata* (Herbst) and *Homola Cuvieri*, Risso, occur in the Mediterranean and Atlantic. *Homola orientalis*, Henderson, is a Pacific species.

Latreillia, Roux, 1828, has a triangular carapace. The eye-stalks are very long and slender, cylindrical, turned forwards, and divergent. The legs are slender and cylindrical, the three middle pairs being very long. The four species belonging to this genus are apportioned two to Japan, one to Australia, and one, *Latreillia elegans*, Roux, to the Mediterranean and Atlantic. The figures in Plate V. represent the Japanese *Latreillia valida* of de Haan, from whose work they are copied on a reduced scale. At the first glance any one would be tempted to place the genus among the spider-crabs in the tribe Oxyrrhyncha, but de Haan showed the impropriety of this. 'The same structure,' he says, 'which prevails in *Dromia* and *Homola* is found in the species of *Latreillia*. They agree in the organs

of feeding, motion, and generation, and in the fabric of the trunk within. The vulvæ are not in the trunk, but in the bases of the third pair of legs. The sternum is deeply excised between the last pair of legs; the turkish saddle[1] and median apodeme are wanting; the transverse septum of the apodemes forms in the middle a central yoke and central canal. Further, they show a peculiar affinity to *Homola* by the eye-stalks, which are very long, thin, apically inflated, as good as free,[2] by the first antennæ not retractile into fossettes, by the first and third maxillipeds, which so agree in the two genera that they can scarcely be distinguished. With the Maiacea, therefore, *Latreillia* cannot be confounded, although the form of the trunk is triangular, the legs are very slender, the epistome is quadrate, and of the branchiæ there are ten pairs, of which three are connected with the maxillipeds, two with the chelipeds, and three with the following legs, but the last united with the penultimate legs.'

Latreillopsis, Henderson, 1888, with a type species, *Latreillopsis bispinosa*, from the Philippine Islands, 'occupies an intermediate position between the genera *Homola* and *Latreillia*. From *Homola* it is distinguished by the arrangement of the rostrum and supraorbital spines, the greater length of the ocular peduncles, and more especially by the elongated cylindrical legs. In *Latreillia*, on the other hand, the frontal region is narrow and produced so as to give the carapace a triangular outline, the supraorbital spines are more strongly developed, and the eye-stalks and legs are of greater length.' It may perhaps be regarded as something more than a mere coincidence that this link between *Homola* and *Latreillia* was obtained by the *Challenger* in one of the two localities in which the same vessel took specimens of those two genera.

Homologĕnus, A. Milne-Edwards, 1888, bears a name altered from the pre-occupied *Homolopsis*, 1880. It differs

[1] The expression 'posterior turkish saddle,' is applied by Milne-Edwards to the small arch formed by the sternal apodemes which spring from the hind margin of the last segment of the trunk.

[2] The Latin is *totis quantis liberis*.

from *Homola* in having a more ovoid carapace, a more developed rostrum, feebler legs, and especially in the form of the eyes which are very small and not narrowed at the base.

Here also should perhaps be placed some Australian species of the genus *Paratymolus*, Miers, 1879, in which the carapace is deflexed in front, flat behind, with the sides nearly straight, the 'front' being prominent and narrow. For a new family Paratymolidæ Mr. Haswell gives the characters, 'carapace in general form similar to the *Maioidea*. External maxillipedes partly over the epistome.' He thinks that it would perhaps be better placed among the *Corystoidea*. Mr. Miers, however, does not agree with this view, but thinks that it ought to stand near the Dromidæ. It is an argument the more for including the present tribe in the Brachyura, that two experts should be unable to agree whether a genus belongs to it or another tribe which is brachyuran beyond question.

Legion 2.—*Ranininea.*

The carapace is ovate-oblong, with the regions not defined, and the 'front' of varying width. The orbits are well marked. The first antennæ are without special fossettes, and are placed to some extent behind the second pair. The third maxillipeds are moderately elongate. The sternal plastron or breastplate is wide anteriorly. The walking-legs have the terminal joint broad and compressed; the last pair of legs are small and subdorsal in position. The vasa deferentia of the male are protruded. The pleon is short, partially extended, not folded under the trunk, with four pairs of appendages in the female.

Dr. Henderson includes the epithet 'smooth' in the description of the carapace, but this is obviously unsuited to *Ranina scabra*.

Dr. Boas has ingeniously suggested that the position of the vulvæ in the bases of the legs instead of in the sternal plastron has been brought about by the extreme narrowing of the plastron, and this may well have been

so, though such a species as *Petalomera pulchra* in the preceding legion does not seem to suit the theory. One may, however, suppose that in some instances a re-widening of the plastron may have been developed without any rearrangement as to the position of the vulvæ.

This legion contains the single family Raninidæ, for which, therefore, no separate character is needed. It includes some nine genera, limited to the warm seas, and inhabiting chiefly the tropics, with a range of depth apparently not exceeding 300 fathoms.

Ranina scabra (Fabricius), originally called *Cancer raninus*, Linn., and afterwards *Ranina serrata*, Lamarck, and *Ranina dentata*, Latreille, from Amboina and the Sandwich Islands, was known to fame long before a separate genus was established for it. The carapace has been compared to an inverted triangle. It is very broad anteriorly, but the sides slope very gradually to the rounded hinder margin. The eye-stalks are three-jointed, strongly geniculate, and have a very deep orbit. The pterygostomian regions of the carapace unite with the sternal plastron so as completely to separate the third maxillipeds from the chelipeds. The plastron itself is anteriorly almost trefoil-shaped, but to the rear becomes linear. The branchiæ, Milne-Edwards says, are arranged as in the Brachyura, but in the conformation of the respiratory cavity there is a peculiarity of which he knew no other example. As in the Leucosiidæ, the carapace is joined to the sternum and the cavity of the sides, without leaving above the base of the feet or maxillipeds any space for the entrance of the water necessary for breathing, but the afferent channel instead of being pierced beside the efferent channel, on the sides of the mouth, is situated behind and has a special opening below the base of the pleon. This view, however, is criticised by de Haan in a passage that is not free from perplexity. 'In *Portunus* and *Grapsus*,' he says, 'the water is brought to the branchiæ by a double path and removed by a double path; it reaches the branchial cavity by the mouth and the apertures near the base of the chelipeds; but it passes out both by the space between the inferior lateral margin

of the trunk and the epimera and by two ducts under the insertion of the pleon. In *Ethusa* the case is the same.

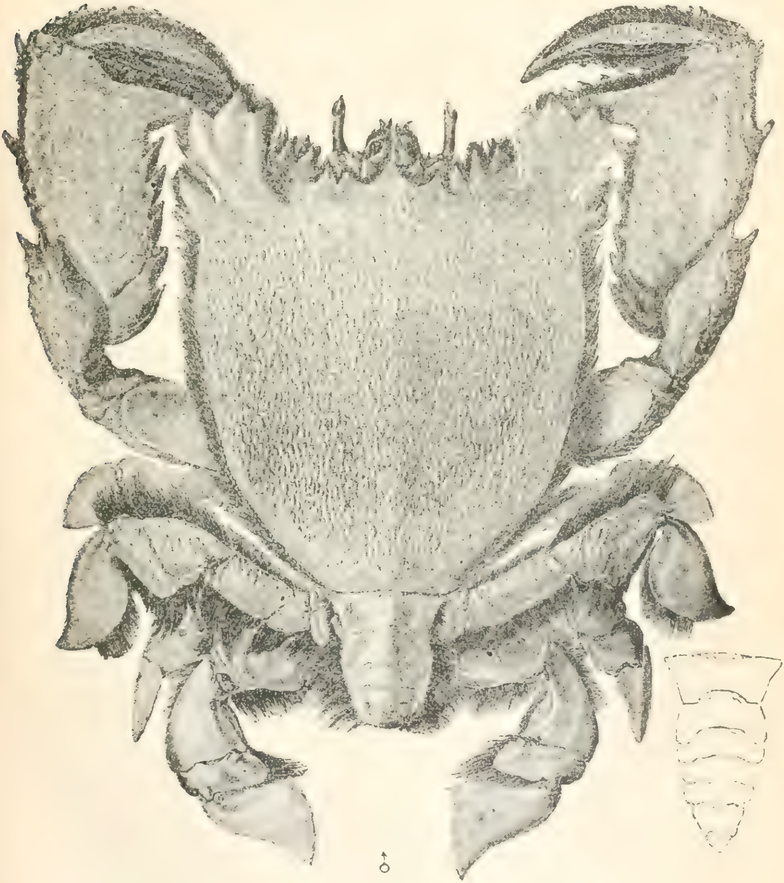


FIG. 11.—*Ranina scabra* (Fabricius), a male specimen, with separate figure of the pleon [de Haan].

In *Calappa* and *Matuta* the hinder ducts are not below but close to the pleon over the first joints of the fifth pair of

legs. In *Dorippe*, *Leucosia*, and *Ranina*, the lower border of the trunk closely coheres with the epimera (compare Milne-Edwards, vol. 2, p. 193). In the first the anterior apertures, in which the first joints of the third maxillipeds work, are remote from the base of the chelipeds; but in the following they are altogether wanting; so that these have only one path on each side by which the water reaches the branchiæ, and one by which it is withdrawn. The hinder ducts in *Ranina* are broader than in other families and amplified by lateral apophyses, but otherwise in *Portunus* and *Grapsus* they are in the same place. The water appears to enter the branchial cavity by the anterior apertures, and to issue by the hinder ones, and not to have a diverse or in *Ranina* and *Leucosia* a contrary motion (compare Milne-Edwards, vol. 1, p. 88, vol. 2, p. 194). In the anterior part there is a force, namely the movement of the maxillipeds, by which the water is brought in; that being expelled behind, follows the movements of the body; the apertures beside the base of the chelipeds and the branchial appendages of the maxillipeds are ciliated on the margin, and by these cilia alien bodies are kept away from the branchiæ, when water is brought to them from in front, whereas [they would be] of no use but a hindrance to breathing, were the water brought from behind.'

Fritz Müller refers to the statement made by Milne-Edwards about the breathing arrangements of *Ranina*, but does not mention de Haan's contrary opinion. Fritz Müller himself unfortunately had not had an opportunity of personally investigating the question Judging from Milne-Edwards' figure of *Ranina dentata*, it would appear to have an arrangement of the pterygostomian regions not unlike that already described in the genus *Sesarma*, by which the crab when on dry land is enabled for a long time to go on breathing the same small stock of sea-water. Such an arrangement would undoubtedly be convenient for the *Ranina*, if the story be true that it has a decided propensity for climbing on to the roofs of houses. Milne-Edwards attributes this story to Rumphius, but nothing of the kind appears to be included in that author's account

of his *Cancer raniformis*, though in the next preceding description he tells of a swift-running 'dog-crab,' *Cancer caninus*, which is said to burrow under houses and enter them. When the limbs of *Ranina* are drawn together it is said to look not unlike a frog, a resemblance to which the generic name points, as well as the trivial name of frog-crab, and the specific name *raniformis* given it by Rumphius.

Raninoides, Milne-Edwards, 1837, is nearly allied to *Ranina*, but has the last pair of legs very short and thread-like instead of equal in size and similar in shape to the preceding flattened pair. In *Raninoides personatus*, Henderson, the pterygostomian areas are described as being strongly granulated as well as slightly pubescent, and the same is said of the type species of a new genus, *Notopoides latus*, Henderson, 1888. In the female of this species there is an ovoid median opening in the sternum, between the third and fourth pairs of legs. *Raninoides personatus* has a similar opening but of very small size. The function of these apertures does not appear to have been explained.

Notŏpus, de Haan, 1841, includes several species, in which the last pair of legs are of moderate size, not filiform. As the name of the genus implies, their position is dorsal, and this, though a character common to the family, is again emphasised in the specific name of *Notopus dorsipes* (Fabricius). Of a crustacean allied to this, Darwin, in his 'Naturalist's Voyage,' gives the following account:—'During our different passages,' he says, 'south of the Plata, I often towed astern a net made of bunting, and thus caught many curious animals. Of Crustacea there were many strange and undescribed genera. One, which in some respects is allied to the Notopods (or those crabs which have their posterior legs placed almost on their backs, for the purpose of adhering to the under side of rocks), is very remarkable from the structure of its hind pair of legs. The penultimate joint, instead of terminating in a simple claw, ends in three bristle-like appendages of dissimilar lengths—the longer equalling

that of the entire leg. These claws are very thin, and are serrated with the finest teeth, directed backwards: their curved extremities are flattened, and on this part five most minute cups are placed which seem to act in the same manner as the suckers on the arms of the cuttle-fish. As the animal lives in the open sea, and probably wants a place of rest, I suppose this beautiful and most anomalous structure is adapted to take hold of floating marine animals.'

Lyreidus, de Haan, 1841, has the eye-stalks short and the orbits are ill-defined, which is contrary to the family character. The genus was originally instituted for *Lyreidus tridentatus*, the lyre-shaped crab of Japan. That species has been traced southwards to Australia; another species, *Lyreidus Bairdi*, S. I. Smith, has been found off the east coast of the United States.

Zanclifer, Henderson, 1888, has the eyes rudimentary, with corneæ of small size though pigmented, on short peduncles, in ill-defined orbits. The first antennæ are small, completely concealed by the massive peduncles of the second pair, which meet together in the middle line. The name means sickle-bearing, in allusion to the uncinate character of the terminal joint in the walking-legs. There is at present only one species, *Zanclifer caribensis* (de Freminville), and of this only two specimens are known. One of these, the figure of which is here reproduced, was obtained by the *Challenger* off the coast of Brazil, the other was taken more than forty years earlier by M. de Freminville in the Caribbean Sea. The French captain described it under the name of *Eryon caribensis*, thus referring it to a fossil genus with which it has nothing to do, and making important mistakes in the description which were pointed

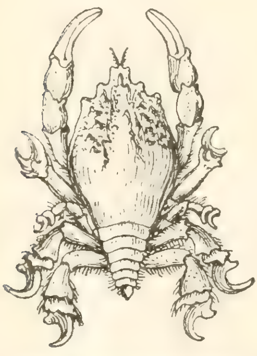


FIG. 12. *Zanclifer caribensis* (de Freminville) [Henderson].

out by Milne-Edwards a few years afterwards. Dr. Henderson was only able to identify the *Challenger* specimen with de Freminville's by help of a pencil-drawing pointed out to him by Professor Alphonse Milne-Edwards in the library of the Natural History Museum at Paris. The elder Milne-Edwards, though assigning the species to the vicinity of the Raninidæ, did not alter the generic name. Judging by the rudimentary nature of the eyes and the structure of the limbs, Dr. Henderson conjectures that this crustacean may be fossorial in habit. If it be so, the rarity of its capture would be the less to be wondered at.

To one of the genera of this family may probably be assigned the West-Indian crab, which for some inscrutable reason has been called the Mamma Shrimp. It is figured and described by Patrick Browne in his 'History of Jamaica.' Herbst (Bd. I., p. 196), in 1790, supposed it to be a near relation of *Corystes cassivelaunus*, but this notion is based only on a very slight superficial resemblance between the two species.

Since *Lyreidus* and *Zanclifer* agree in having the orbits ill-defined, the statement that in this legion 'the orbits are well marked' is too absolute. In the definitions of natural history, where living things are concerned, almost every assertion sooner or later requires to be qualified by the adverb 'usually.'

CHAPTER XI

SUB-ORDER II.—MACRURA

The carapace in general is shorter than the pleon and has the 'front' produced into a more or less decided rostrum. The stalked eyes are not enclosed in orbits, but usually rest in a hollow on the upper surface of the basal joint of the first antennæ. Both pairs of antennæ are generally elongate, the first not planted in fossettes, the second usually carrying a scale or acicle attached to the second joint. The third maxillipeds are elongated and pediform. The five pairs of peræopods or limbs of the trunk vary greatly, as any of them may be chelate and any of them simple. The sternal plastron or breastplate is linear in general. The vulvæ of the female open in the basal joints of the third pair of legs, and the vasa deferentia of the male pass through those of the fifth pair. The pleon is seldom completely reflexed against the breastplate. Of the six pairs of pleopods the first varies from the succeeding, and all may be absent; but except in the Lithodidæ that belonging to the sixth segment is always present, this pair with the telson forming the *Rhipidura* or tail-fan. Otoliths of some kind are very commonly present in the basal joint of the first antennæ.

In the above definition the Pterygurous division of Milne-Edwards' Anomura is included. After explaining the grounds upon which Milne-Edwards had introduced his tripartite arrangement, de Haan makes the following comment upon it:—'The division of the Decapoda into Brachyura and Macroura is for various reasons to be pre-

ferred. The Anomoura are not distinguished from the Brachyura and Macroura by any common character; from the former they differ by the disposition of the vulvæ, from the latter by not having a fan-shaped termination to the pleon. But all the organs vary extremely in the Anomoura, and no bond of connexion between the Apterura and Pterygura is found either in the shape of the antennæ, mouth, maxillipeds, trunk, plastron, branchiæ, or in that of the pleon. The Anomoura contain forms which differ more from one another, than the Brachyura do from the Macroura. By the Anomoura the closest relationships are torn asunder, as the Dromiacea from the Maiacea, the Raninoidea from the Leucosiæ, the Porcellanidea from the Galatheæ, the Megalopidea from the Astacoidea.'

This criticism, published in 1841, appears now to be winning deserved acceptance. The recent researches of M. F. Mocquard into the armature of the stomach also show the Anomura to be an artificial division. With the transfer of the Pterygura to the Macruran sub-order, in which all the families are pterygurous, the name becomes inappropriate and may give place to the older name Anomala, used by Latreille, though in a narrower application. Any slight inconvenience that may result from the similarity of name between the Brachyura anomala and Macrura anomala will be compensated by the reminder thus supplied that these two tribes correspond with the collective Anomura of Milne-Edwards.

The Macrura contain the following tribes:—Anomala, Thalassinidea, Scyllaridea, Astacidea, Stenopidea, Penæidea, Caridea, among which will be found along with others those popularly well known as Hermit Crabs, Lobsters, Crayfishes, Prawns, and Shrimps.

The following Table shows the subdivision of the tribes into legions and families:—

Macrura

Tribes.	*Legions.*	*Families.*
Anomala	Hippinea	Hippidæ.
		Albuneidæ.
	Lithodinea	Lithodidæ.
	Pagurinea	Cœnobitidæ.
		Paguridæ.
		Parapaguridæ.
	Porcellaninea	Porcellanidæ.
	Galatheinea	Galatheidæ.
Thalassinidea		Thalassinidæ.
		Callianassidæ.
		Axiidæ.
		Thaumastochelidæ.
Scyllaridea		Scyllaridæ.
		Palinuridæ.
Astacidea		Eryontidæ.
		Nephropsidæ.
		Potamobiidæ.
		Parastacidæ.
Stenopidea 211.		Stenopidæ.
Penæidea 213.		Penæidæ.
		Sergestidæ.
Caridea	Crangoninea	Crangonidæ.
	Polycarpinea	Nikidæ.
		Alpheidæ.
		Hippolytidæ.
		Pandalidæ.
	Monocarpinea	Thalassocaridæ
		Atyidæ.
		Pontoniidæ.
		Caricyphidæ.
		Acanthephyridæ.
		Palæmonidæ.
		Nematocarcinidæ.
		Tropiocaridæ. (?)
		Stylodactylidæ.
		Pasiphæidæ.
		Oodeopidæ.
	Haplopodinea	Hectarthropidæ.

TRIBE I.—ANOMALA.

The pterygostomian regions are free from the epistome and marked off from the back by a suture or continuous furrow. The fifth pair of legs are generally weak, not fit either for walking, swimming, or grasping food and prey.

The tribe embraces five legions, Hippinea, Lithodinea, Pagurinea, Porcellaninea, Galatheinea.

Legion 1.—*Hippinea.*

The carapace is ovate or subquadrate, comparatively smooth, the regions ill defined, the 'front' broad. The corneæ of the eyes are small. The first antennæ are in general strongly developed, with one flagellum elongate, the other of moderate size or absent. The second antennæ have usually a short flagellum and a massive peduncle of four or five joints, with or without a movable acicle on the second. The third maxillipeds are moderately broad, sub-operculiform. The walking-legs have a flattened terminal joint. The fifth pair are slender and filiform and folded under the preceding pair. The sterna of the trunk are linear. The pleon is partially extended, with the telson large, longer than broad, and the preceding segment carrying a pair of biramous lamellar appendages, not so arranged as to form a rhipidura. The males have no appendages to the pleon but those of the penultimate segment.

The members of this legion inhabit the shallow waters of tropical and subtropical seas. They are divided between the two families of the Hippidæ and Albuneidæ.

Family 1.—*Hippidæ.*

The third maxillipeds are sub-operculiform, with a broad fourth joint; the exopod is wanting. The first pair of legs are sub-cylindrical and not chelate. The telson is elongate, lanceolate.

This family includes three genera.

Hippa, Fabricius, 1793, has been much restricted since it was first instituted. It is now especially distinguished

from its companions by the large and long flagellum of the second antennæ. *Hippa emeritus* (Linn.) is regarded by Mr. J. E. Ives as a very variable species widely distributed on the east and west coasts of North and South America. It is used, he says, by the fishermen for bait, and large numbers are dug from the sand. It is not unlikely, as suggested by Milne-Edwards, that *Hippa talpoida*, Say, the 'mole-like' Hippa, is the same species. It was upon this that Professor S. I. Smith made his observations at the United States' Biological Station at Wood's Hole, Massachusetts, in the summer of 1875. He was there able to obtain a nearly complete series of the post-embryonal stages, and has since elaborately described the second, third, and last zoëa forms, and the succeeding megalopa condition. Some of his figures are reproduced on Plate IV. He observed that the adults preferred a very narrow zone of the shore, at or very near low-water mark, where they lived gregariously, burrowing in the loose and changing sands.

'The smooth, oval form of the animal,' he says, 'with the peculiar structure of the short and stout second, third, and fourth pairs of thoracic legs, enables them to burrow with far greater rapidity than any other crustacean I have observed. Like many other sand-dwelling crustaceans, they burrow only backwards; and the wedge-shaped posterior extremity of the animal, formed by the abrupt bend in the abdomen, adapts them admirably for movement in this direction. When thrown upon the wet beach, they push themselves backward with the burrowing thoracic legs, and by digging with the appendages of the sixth segment of the abdomen slightly into the surface, direct the posterior extremity of the body downward into the sand.'

The second antennæ are generally held between the second and third maxillipeds, with the peduncles crossed in front, and the flagella curved down and entirely round the mouth so that the setæ with which they are densely armed all project inward. Their function is not unreasonably supposed to be that of removing objectionable

particles from the other appendages within their reach. For this brushing service they must be well adapted, since in ordinary adult specimens there are from a hundred to a hundred and fifty joints in the flagellum, and from eight to twelve setæ to each joint. Most of these setæ are only slightly bent, but armed on the outside of the curve with a great number of variously shaped teeth. On either side of each bundle, however, there is a very long seta, convolutely curved inward at the extremity, and along nearly its whole length densely furnished with long, slender, secondary setæ, arranged in a double series on the inner side of the curve. Already in the megalopa stage, Professor Smith found that the mandibles had become thin and foliaceous and completely consolidated with the walls of the oral opening. This extremely unusual condition of those organs persists in the adult, and seems to have perplexed the few naturalists who have earlier examined them. It must be a subject of surprise that a crustacean of such a family as this should be able to dispense with the biting power usually so strongly developed in the mandibles. But we are told that in all specimens examined the alimentary canal was filled with fine sand, and as the material from the stomach showed under the microscope a small quantity of vegetable matter, the inference is not improbable that, much after the fashion of the earthworm, the creature obtains nutriment from the sand which it passes through its body. Milne-Edwards was evidently under the impression that the true second segment of the pleon in this genus was its first segment, but Professor Smith has shown very clearly that the first pleon-segment is in the adult coalesced with the trunk, a thing very unusual but none the less in this case quite to be depended on.

Remipes, Latreille, 1806, has the peduncle of the second antennæ large, but the flagellum quite small. The first segment of the pleon is free, the telson lanceolate, of great length. As in *Hippa*, the female carries appendages on the second, third, fourth, and sixth segments of the pleon. The founder of the genus and several writers since have supposed the first pleon-segment to be the last segment of

the trunk, a mistake which Professor Smith has now corrected. *Remipes testudinarius*, Latreille, has been recorded by this and various other names from many parts of the Indo-Pacific region. Its true name would seem to be *Remipes adactylus* (Fabricius). *Remipes scutellatus* (Fabricius) is found in the Atlantic.

Mastigochīrus, Miers, 1877, meaning 'with a whip-like hand,' was previously called *Mastigŏpus* by Stimpson in 1858, but the name being pre-occupied had to be changed. Its chief distinction from *Remipes* rests on the form of the long and slender first pair of legs, which have the terminal joint subdivided. The type specimen of *Mastigochirus quadrilobatus*, Miers, came from the Philippine Islands. A comparison of this with others subsequently obtained by the *Alert* in the Prince of Wales' Channel showed Mr. Miers that 'the number of joints in the terminal flagelliform portion of the anterior limbs (which are imperfectly seen on account of the hairs with which they are thickly clothed) was understated in the original description; instead of being ten or twelve, they are usually twice as numerous.'

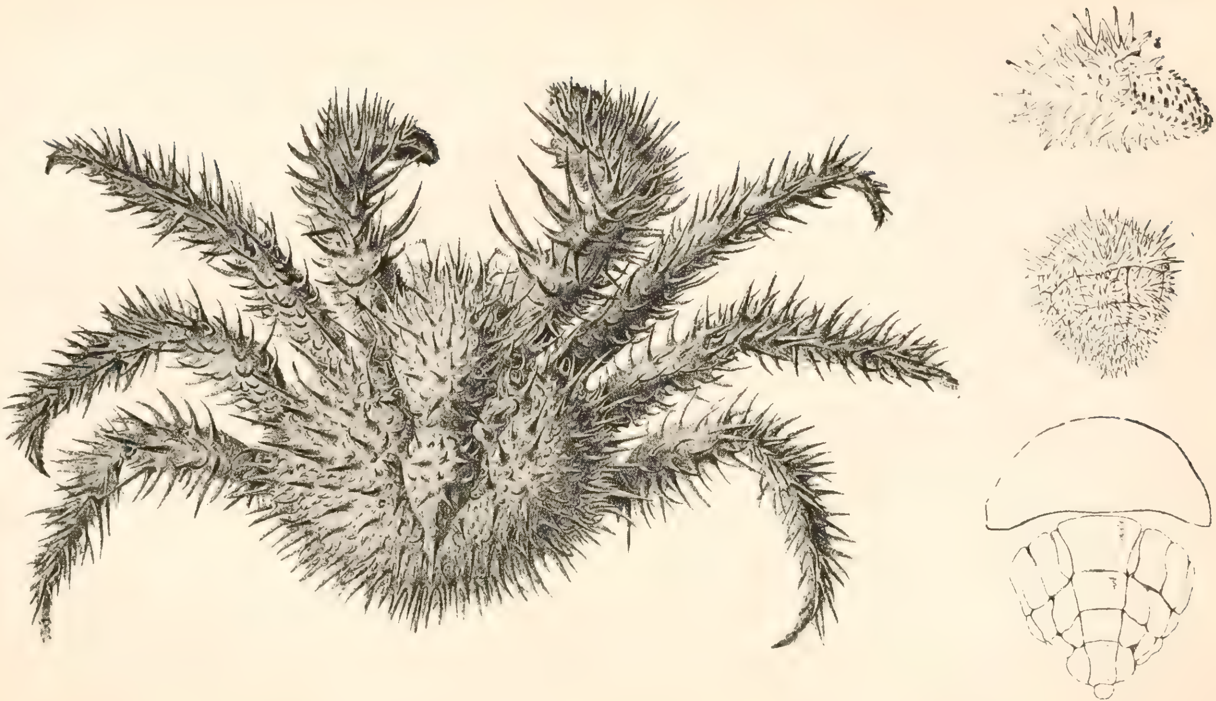
Family 2.—Albuneidæ.

The third maxillipeds are subpediform, with the fourth joint not greatly dilated; there is a small exopod. The first pair of legs are flattened and chelate. The telson is ovoid.

Albunea, Fabricius, 1798, has for its type species the little *Albunea symnista* (Linn.), from eastern waters. The carapace is strongly grooved behind for the reception of the small first segment of the pleon. In Milne-Edwards' 'Histoire Naturelle des Crustacés,' vol. 2, p. 202, the distinguishing characters of *Remipes* and *Albunea* are transposed, but the error is subsequently corrected.

Legion 2.—Lithodinea.

The carapace is broadly ovate, uneven, with the regions well defined and a prominent rostrum. The first antennæ have cylindrical peduncles of moderate size and short



Lithodes histrix, de Haan.

flagella. The second antennæ have an acicle on the second joint. The third maxillipeds are subpediform, with the third and fourth joints elongate. The first legs of the trunk are chelipeds; the three following pairs are well developed, more or less cylindrical, and the last pair are slender, chelate, folded in the branchial chambers. The sternal plastron is wide. The pleon is bent under the trunk, having the first segment small and dorsally fused with the second; it has appendages only in the female, these being a rudimentary pair on the first segment, and, as a rule, a single one-branched appendage on the left side of each of the four following segments.

The single family Lithodidæ has the characters of the legion. The members of it are found in the cold and temperate shallow waters of both hemispheres, but deep-sea dredgings, especially those of the *Talisman*, have shown that at great depths, even below a thousand fathoms, species occur in the tropics. Thus, it has been pointed out, the Arctic and Antarctic zones are connected by a submarine tunnel of cold water. The genera are not very numerous. One is found in the waters of Great Britain.

Lithōdes, Latreille, 1806, is now represented by several fine species from distant parts of the world. *Lithodes maia* (Linn.) has long been known. It is the devil-crab of the Norwegian fishermen, according to Herbst. Bell calls it the Northern Stone Crab, and is surprised that what he calls its slight resemblance to *Maia squinado* should have caused it to be at times confused with that species. The superficial resemblance, however, is not inconsiderable, when the dorsal view alone is regarded. The ventral view permits of no confusion or mistake, for in *Lithodes* the pleon has in the third, fourth, and fifth segments paired calcified plates, the median portion being membranous with scattered calcareous particles. In the female the plates are greatly developed on the left side to the disparagement of those on the right, producing a want of symmetry akin to that which is found in the Paguridæ. The rostrum in *Lithodes* is spinulose, like almost all the other external parts of the animal. *Lithodes histrix*, de

Haan, portrayed in the adjoining Plate, is called by the Japanese Aka-oni-gani, which according to de Haan means the red crab of the devil. *Lithodes Agassizii*, Smith, has been taken in the Atlantic from depths of a thousand and twelve hundred and fifty fathoms. *Lithodes Murrayi*, Henderson, was obtained in the Southern Ocean from three hundred and ten fathoms depth.

Cryptolithōdes, Brandt, 1849, with its species *Cryptolithodes typicus*, Brandt, from California, is especially distinguished by the great development of the carapace, which completely hides the legs, antennæ, and pleon, and these when viewed from below appear to be placed in the bottom of a cup-like cavity. According to Stimpson, this development of the carapace is unequalled in any even of the higher decapods, not excepting *Cryptopodia* and *Æthra*, and this is the only instance in which the carapace conceals all the feet.

Echidnocĕrus, White, 1848, contains one or two massive species from the West Coast of America, the carapace in *Echidnocerus setimănus* (Gibbons) sometimes measuring ten inches in length and as many in width, and by a weight of over seven pounds exceeding that of the carapace even of the giant *Macrocheira* of Japan.

FIG. 13. *Lomis dentata* [de Haan].

Lomis, Milne-Edwards, 1837, has a very small rostrum, consisting of a single tooth. The little *Lomis dentata* is described by de Haan from Japan. Its carapace about half an inch in diameter forms a strong contrast to the preceding species.

Paralomis, Stimpson, 1858, has a rostrum which is usually trispinose, and in this genus the third, fourth, and fifth segments of the pleon in the female have the lateral plates subequal, and the median portion occupied by a series of large calcareous plates instead of particles.

Hapalogaster, Brandt, 1851, has the appendages of the second pleon-segment in the female biramous instead of one-branched as in the other Lithodidæ. Its second antennæ are much longer than the carapace, as in *Porcel-*

lana. The pleon is soft as in a hermit-crab, but reflexed.

That the fifth pair of legs in the crustaceans of this family should be folded in the branchial chambers must seem a very strange arrangement, unless consideration is directed to the advantage which may thus be attained in keeping the branchiæ clear from parasites.

Legion 2.—*Pagurinea.*

The carapace is elongate, becoming weak or membranaceous behind the cervical groove, which divides the gastric and hepatic regions from the cardiac and branchial. The second antennæ have an acicle. The third maxillipeds are subpediform, with the third and fourth joints elongate. The chelipeds and two following pairs of legs are well developed, the last two pairs are small, one or both being usually chelate. The sternal plastron is linear. The pleon is spirally twisted or extended; the tergal elements are as a rule rudimentary. There is generally a single biramous appendage to the second, third, fourth, and fifth segments of the pleon on the left side, the first three of these being well-developed and ovigerous in the female. The sixth segment in both sexes has a pair of appendages.

Common as the Hermit-Crabs are between tide-marks, they are also found in depths of over two thousand fathoms. The legion contains three families, the Cenobitidæ, Paguridæ, and Parapaguridæ. The first two of these families are phyllobranchiate, that is, have the branchial plumes formed by a series of foliaceous plates, whereas the third family is trichobranchiate, having the branchial plumes made up of long cylindrical filaments.

Family 1.—*Cenobitidæ.*

The first antennæ have a very elongate peduncle, its first joint deflexed and as long as or longer than the eye-stalks, the second and third joints narrow and cylindrical; one of the flagella enlarged. In the second antennæ the

peduncle is compressed, the terminal joint long. The branchial plumes are laminar.

The species are partially terrestrial. The family includes two well-known genera.

Birgus, Leach, 1815, is a genus of eminent distinction. The broadly ovate carapace covers large branchial chambers, of which, however, the fourteen pairs of small branchiæ only occupy a small fraction, but on the other hand, in evident adaptation to an aerial life, the lining membrane of the chambers is covered with vascular pulmonary outgrowths. The pleon is not twisted. It is very broad. Dorsally its first segment is represented by a corneous band, as the four following are by four corneo-calcareous overlapping plates, flanked by small corneous pieces which seem to represent the side-plates. The second, third, and fourth segments have a large biramous appendage on the left side, but only in the female. All the underside of the pleon is membranous, until a quadrilateral plate is reached which represents the sixth segment and which gives attachment to a rudimentary appendage on each side and to the terminally rounded telson.

The account given by Darwin of that which is probably the type and perhaps the only species of this genus is too interesting to be omitted. When treating of the Coral Islands of the Pacific, he says:—'I have before alluded to a crab which lives on the cocoa-nuts: it is very common on all parts of the dry land, and grows to a monstrous size; it is closely allied or identical with the Birgos latro. The front pair of legs terminate in very strong and heavy pincers, and the last pair are fitted with others weaker and much narrower. It would at first be thought quite impossible for a crab to open a strong cocoa-nut covered with the husk; but Mr. Liesk assures me that he has repeatedly seen this effected. The crab begins by tearing the husk, fibre by fibre, and always from that end under which the three eye-holes are situated; when this is completed, the crab commences hammering with its heavy claws on one of the eye-holes till an opening is made. Then turning round its body, by the aid of its posterior

and narrow pair of pincers, it extracts the white albuminous substance. I think this is as curious a case of instinct as ever I heard of, and likewise of adaptation in structure between two objects apparently so remote from each other in the scheme of nature, as a crab and a cocoa-nut tree. The Birgos is diurnal in its habits; but every night it is said to pay a visit to the sea, no doubt for the purpose of moistening its branchiæ. The young are likewise hatched, and live for some time, on the coast. These crabs inhabit deep burrows, which they hollow out beneath the roots of trees; and where they accumulate surprising quantities of the picked fibres of the cocoa-nut husk, on which they rest as on a bed. The Malays sometimes take advantage of this, and collect the fibrous mass to use as junk. These crabs are very good to eat; moreover, under the tail of the larger ones there is a great mass of fat, which, when melted, sometimes yields as much as a quart bottle full of limpid oil. It has been stated by some authors that the Birgos crawls up the cocoa-nut trees for the purpose of stealing the nuts: I very much doubt the possibility of this; but with the Pandanus[1] the task would be very much easier. I was told that on these islands the Birgos lives only on the nuts which have fallen to the ground. Captain Moresby informs me that this crab inhabits the Chagos and Seychelle groups, but not the neighbouring Maldiva archipelago. It formerly abounded at Mauritius, but only a few small ones are now found there. In the Pacific, this species, or one with closely allied habits, is said[2] to inhabit a single coral island, north of the Society group. To show the wonderful strength of the front pair of pincers, I may mention, that Captain Moresby confined one in a strong tin-box, which had held biscuits, the lid being secured with wire; but the crab turned down the edges and escaped. In turning down the edges, it actually punched many small holes quite through the tin!'

Mr. Boddam-Whetham, in his 'Pearls of the Pacific' (1876), declares that the crab first ascends the tree to push

[1] See *Proceedings of Zoological Society*, 1832, p. 17.
[2] Tyerman and Bennett, *Voyage, &c.*, vol. ii. p. 33.

down a nut, descends to strip it of its husk, and then 're ascends the tree, if the situation is favourable, and holding the nut by a bit of the fibre, which it leaves on for the purpose, it lets it fall upon a rock, or stone, and thus breaks it.' I could wish that he had spoken of having seen this wonderful manœuvring with his own eyes. Dr. T. H. Streets declares that 'the wonderful stories about these crabs climbing the trees after cocoa-nuts are purely fictitious.'

Rumphius is the original authority for the statement that these crustaceans in their night ramblings ascend the cocoa-nut palms and appropriate the nuts. It is to their love of that food that they owe the title of the robber-crab. It is said that they can be lured out of their holes by presenting to them a cocoa-nut attached to the end of a stick. Rumphius says that this crab in the language of Amboina is named Catattut and Atattut, but that it is familiarly called by his own countrymen 'Don Diego in 't volle harnasch,' its Latin name being Cancer crumenatus, of which the Belgic equivalent is Beurs-Krabbe. This title of purse-crab alludes to the packet of fat under the tail, which is accounted a delicious marrow-like morsel by those who like it. The oil from it is, or once was, regarded as a panacea for sprains and contusions. Herbst declares that the claws of the Birgus are so strong that they easily crack a cocoa-nut which a human being could not break open with a stone. He says, moreover, that if they have once seized hold of an object, it is easier to break the claws than to make them let go. Yet what cannot be done by force may be achieved by cunning, for if, he says, you just tickle the creature under the tail, it becomes so irritated that it gives itself a nip on the tail, and dies by its own claw! Herbst wrongly figures the fourth pair of legs as simple, whereas they are, in fact, chelate. The naturalists of the *Challenger* were informed by an intelligent native at Samboangan that the female crab carries about large masses of the eggs with it in the month of May, and retains them so attached until the young are developed just like the parent. At Samboangan it is called 'Tatos,' and appreciated as

a delicacy. The naturalists visited Santa Cruz-Major in search of it for the curious reason that there are no pigs in that island. 'Wild pigs,' they say, 'destroy not only these crabs, but dig up Shore Crabs (*Ocypoda*) and Land Crabs from their holes. In Ceylon, near Trincomali, the wild swine come down every night to the beach to dig up crabs, and large tracts of sandy beach are ploughed up by them in the search.'

Cenobita, Latreille, 1826, while agreeing with the preceding genus in the character of the antennæ, approaches the next family in the formation of the pleon. This is soft and membranous and twisted on itself; the dorsal plates are narrow, with appendages to the segments as in *Birgus*, but those of the sixth segment are well developed and unsymmetrical, the appendage on the left being the larger. The species protect themselves in a variety of shells, and are widely distributed over the Indo-Pacific region, *Cenobite rugosa*, Milne-Edwards, being within those limits almost ubiquitous.

Family 2.—*Paguridæ*.

The first antennæ have a peduncle of moderate size, the first joint short and stout, the second and third slender and cylindrical; both the flagella are small. In the second antennæ the peduncle is sub-cylindrical. The branchial plumes are laminar. The species are marine. The genera in Dr. Henderson's reckoning are nineteen, two or three of which are included in the British Fauna. In fourteen of the genera the pleon is spirally twisted or bent abruptly, soft and membranous, with imperfect segmentation, while in the remaining five it is not spirally twisted, and it has distinct movable segments which are usually calcified.

Pagūrus, Fabricius, 1793, originally included the whole family of crustaceans that walk about with borrowed shells, though beginning with the above-described *latro*, which has no such domicile. It is now greatly restricted, and it may be useful to point out some of the characters by

which this genus and some of its immediate neighbours are distinguished from one another.

Pagūrus (in restricted sense). The 'front' without distinct rostral projection. Eye-stalks stout, with basal scales usually wide apart. Acicle of second antennæ short and robust, the flagellum long and naked. The third maxillipeds approximate at the base. The left cheliped usually the larger. The fourth pair of legs chelate.

Eupagūrus, Brandt, 1851. The 'front' with a distinct rostral projection. Eye-stalks stout, with basal scales wide apart. Acicle of second antennæ long and slender, the flagellum long and naked. The third maxillipeds distant at the base. The right cheliped usually the larger. The fourth pair of legs subchelate.

Clibanarius, Dana, 1852. The 'front' with a distinct rostral projection. The eye-stalks usually slender, with the basal scales close together. Acicle of second antennæ short, the flagellum naked. The chelipeds subequal and similar. The fourth pair of legs chelate.

Aniculus, Dana, 1852, and *Calcinus*, Dana, 1852, agree with *Clibanarius* as above defined, except that *Aniculus* has the fourth pair of legs subchelate, and *Calcinus* has the chelipeds very unequal.

Diogĕnes, Dana, 1852. There is a movable rostriform process between the eye-stalks, distinct from the rostrum. The acicle of the second antennæ has a broad base; the flagellum is ciliated. The left cheliped is the larger. The fourth pair of legs chelate.

When characters are set out in this way, it would seem that there should be little difficulty in determining to what genus a species belongs, but nature does not always lend itself very obligingly to the necessities of classification. Thus, in regard to *Pagurus similimănus*, Henderson, its author is obliged to say: 'The chelipedes are of equal size, and in every respect similar to one another, belonging essentially to the form which is characteristic of the genus *Clibanarius*,' and presently afterwards, under the species *Clibanarius strigimănus* (White), Dr. Henderson observes: 'As in the case of *Pagurus simili-*

mănus, this species shares the characters of *Pagurus* and *Clibanarius*, though its affinities are more with the latter genus; the chelipedes are subequal, a distinct rostral projection is present, and the ocular peduncles are tolerably long and slender; at the same time the ophthalmic scales are arranged as in *Pagurus*.' He adds that 'the special features of *Clibanarius strigimanus* are the curious striated (stridulating?) areas on the inner surface of the hand of each chelipede, and the narrow and acute terminal portions of the ophthalmic scales.'

In Bell's 'History of British Stalk-eyed Crustacea,' ten species are named and described as belonging to the genus *Pagurus*, but the majority of them are now differently classified. Thus *Pagurus Bernhardus* (Linn.) and *Pagurus ulidianus*, Thompson, both become *Eupagurus Bernhardus* (Linn.); *Pagurus Prideaux* (needlessly altered to *Prideauxii*), Leach, and *Pagurus cuanensis*, Thompson, are likewise transferred to *Eupagurus*, though retaining their original specific names; *Pagurus Thompsoni*, Bell, is a synonym of *Eupagurus pubescens* (Kröyer), *Pagurus Forbesii*, Bell, a synonym of *Eupagurus sculptimanus* (Lucas),[1] and a British species not mentioned by Bell, *Pagurus tricarinatus*, Norman, is now identified with *Eupagurus excavatus* (Herbst). *Pagurus Hyndmanni*, Thompson, *Pagurus lævis*, Thompson, and another British species not mentioned by Bell, *Pagurus ferrugineus*, Norman, are now transferred to the genus *Anapagurus*, the last-mentioned being a synonym of *Anapagurus chiroacanthus* (Lilljeborg). All the nine species are at a glance distinguished from *Pagurus* by having the right cheliped larger than the left. In Bell's two remaining species the left cheliped is the larger. Of these *Pagurus Dillwynii*, Sp. Bate, is a synonym of *Diogenes varians*, Costa, thus leaving to the original genus no British species except *Pagurus fasciatus*, Bell, a species which may be the same as *Pagurus striatus*, Latreille, and which, at any rate as far as Bell was concerned, was not described from nature at all, but from a

[1] G. O. Sars refers the *Pagurus Forbesii*, Bell, to the genus *Spiropagurus*.

coloured drawing supplied him by a friend! Natural history would probably soon be enlivened by many miraculous illustrations if it became lawful to construct a fauna upon the sketches of friends, however trustworthy. It may here be noticed that one of the most attractive figures in Herbst's work is that of his *Cancer megistos*, afterwards called *Pagurus megistus*, but of this Milne-Edwards observes that it appears to be an imaginary species, the bulk of which belongs to a *Pagurus*, while the fan-tail termination has been taken from some lobster-like animal. Many of the Pagurids are very beautifully coloured, but they are decidedly weak about the tail. Just as the quarrymen in old days used to make Ammonites 'perfect' by carving the front of the shell into a serpent's head, so no doubt some Eastern artist made the really handsome Pagurus into a perfect specimen by giving it what he thought a satisfactory tail, regardless of the fact that such an ornament would have made life impossible to the creature itself. He had not before his eyes the fear of J. C. Fabricius, who winds up his acknowledgments to his predecessors by the awe-inspiring denunciation, 'damnandæ vero memoriæ John Hill et Louis Renard, qui insecta ficta proposuere.'

In regard to *Pagurus striatus*, Latreille, or, as it ought perhaps rather to be called, *Pagurus arrosor* (Herbst), the facts of distribution are noteworthy, since the specimens taken in the Mediterranean, among the Philippine Islands, and at Japan, show no points of distinction. When *Eupagurus excavatus* was dredged among the Shetland Isles, Canon Norman, though not then knowing it by its right name, shrewdly suspected that it would prove to be a deep-water Mediterranean form, and as *Portunus tuberculatus*, Roux, and the echinoderm *Spatangus meridionalis*, Risso, had been dredged in the same locality, he takes occasion to remark that 'all deep-water dredging seems to establish this fact more clearly, that deep-water species have a much more extended geographical range than shallow-water and littoral forms. These Mediterranean species must have made their way northwards in the abyss of the sea round the western coast of Ireland, in which

locality they will doubtless at some future day be found.' *Pagurus granulatus*, Olivier, one of the largest Pagurids, being seven inches and a half in length, has a range from the West Indies to the Cape.

The names Hermit-crab and Soldier-crab, as applied to the Pagurids, are of ancient date, the ensconced crustacean being supposed to resemble a hermit in his cell or a warrior in his castle. It is a disputed point whether the Pagurids kill and eat the molluscs before taking possession of their shells. Some writers, as Bell, are persuaded that they do. Others, as Stalio, deny this, maintaining that they are always, as without dispute they are often, content with dead shells. A hermit has from time to time to change its abode to suit its own increase in size, and it is said that when on search for new lodgings, if it meets one of its own kind occupying a desirable shell, it will engage in combat, and if possible take the coveted fortress for itself. As the occupant of the envied shell is likely by the nature of the case to be equal in size to its antagonist, and has besides the point of vantage which its occupancy gives, the attack can seldom be successful, and it must be a lucky chance that has enabled any one to witness such a conflict, at least under natural conditions. In their account of the invertebrate animals of Vineyard Sound and the adjacent waters, Verrill and Smith say:—'Active and interesting little "Hermit-crabs," *Eupagurus longicarpus* [Say], are generally abundant in the pools near low-water, and concealed in wet places beneath rocks. In the pools they may be seen actively running about, carrying upon their backs the dead shell of some small gastropod, most commonly *Anachis avara* or *Ilyanassa obsoleta*, though all the small spiral shells are used in this way. They are very pugnacious and nearly always ready for a fight when two happen to meet, but they are also great cowards, and very likely each, after the first onset, will instantly retreat into his shell, closing the aperture closely with the large claws. They use their long slender antennæ very efficiently as organs of feeling, and show great wariness in all their actions.' The natural pugnacity and greediness of these

creatures may be restrained under the influence of the tender passion, for at the Hamburg Aquarium the late Mr. W. A. Lloyd observed the male *Eupagurus Bernhardus*, in the spring of the year, 'take hold of the shell in which a female was contained, and carry her about for weeks together, grasping the thin edges of the shell, and when the female was fed, the male did not take away the food as he would if a male one fed in his vicinity.' Aristotle supposed that the Pagurids were generated out of earth and mud, and Gesner argues from this that he can never have taken a gravid female out of her shell, or he would have been disabused of his opinion by seeing the bunches of eggs on the appendages of the pleon. Stalio says that the mother takes care to discharge the young ones in some place where they will have a good chance of finding shells appropriate to their size. According to Mr. Spence Bate it is not necessary for the mother to leave her shell in order to release the young, for when they issue from the egg they are ejected by the current of water that passes outward during the process of respiration. He reports that he had himself seen them thus ejected through the branchial passage under the wing of the carapace. The same writer quotes an interesting experience on the part of Mr. Gurney, who found in a capsule of *Buccinum* eggs a little whelk-shell, not larger than No. 5 shot, occupied by a young Hermit-crab about an eighth of an inch long, and in another capsule a second Hermit-crab of similar size, but not ensconced in a shell. Hence it appears that the instinct of seeking an extraneous covering is developed at a very early age. In the earliest stages of life the Pagurids are symmetrical and therefore unsuited to the occupation of a spiral shell. It may not be possible absolutely to prove that in their later phases they have gradually *acquired* the formation that suits them to so peculiar a lodging, but it may at least be said that no other explanation looks equally probable.

The genus *Anapagurus* has been already referred to as containing some British species. This genus and two others form a group by themselves, distinguished from *Eupagurus*

and its immediate neighbours by the possession of a conspicuous appendage in the male at the fifth pair of legs, and distinguished from one another by the shape and

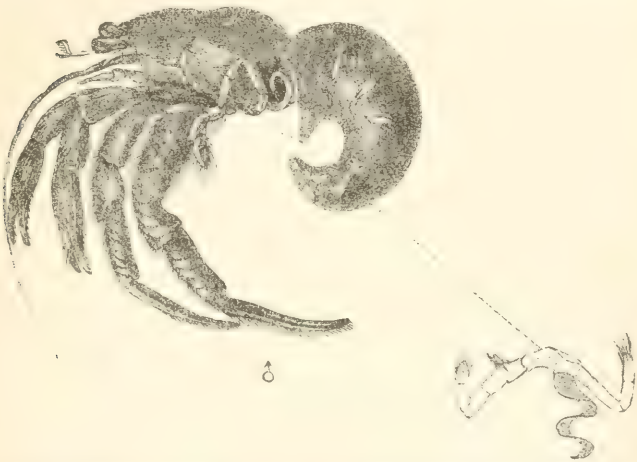


Fig. 14.—*Spiropagurus spiriger* (de Haan), with separate figure of the fifth pair of feet carrying the spiral appendage.

position of that appendage. They are alike in having the fourth pair of legs subchelate.

Spiropagurus, Stimpson, 1858. The fifth leg of the male on the left side has at the base a more or less spirally twisted appendage (the protruded vas deferens).

Catapagurus, A. Milne-Edwards, 1880. The fifth leg of the male on the right side has at the base an appendage curved in one plane round the right side of the pleon.

Anapagurus, Henderson, 1886. The fifth leg of the male on the left side has at the base an appendage which is short and curved, instead of long and coiled.

That the distinguishing feature of *Spiropagurus* did not escape the notice of de Haan is clear from the description, the figures, and the specific name of his *Pagurus spiriger*. This, which is the type species of *Spiropagurus*, is now found to be widely distributed in Eastern waters.

The genus *Ostraconōtus*, A. Milne-Edwards, 1880, and *Tylaspis*, Henderson, 1885, require notice, because, unlike all other Paguridæ, they have the hinder part of the carapace broad and firm, a character to which their names 'shelly-back' and 'callous shield' make reference, whilst they also have the pleon poorly developed. The species *Tylaspis anomala*, Henderson (see Plate VII.), was dredged by the *Challenger* in the mid-South Pacific, from a depth of 2,375 fathoms, the greatest depth, as already mentioned, at which any of the Anomala were found. This strange-looking animal has the pleon not spirally twisted, and the appendages of its sixth segment are almost symmetrical. It is inferred therefore that it occupies some other dwelling-place than a Gastropod shell. This species has in the male a pair of genital appendages on each of the first two segments of the pleon, agreeing in that particular with *Paguristes*, Dana, 1852, and *Sympagurus*, S. I. Smith, 1883. The last-named genus, though belonging to the phyllobranchiate Pagurids, nevertheless shows a slight tendency in the formation of the branchiæ to agree with the next family.

Family 3.—Parapaguridæ.

The definition is the same as that of the Paguridæ, except that the branchial plumes are filamentous.

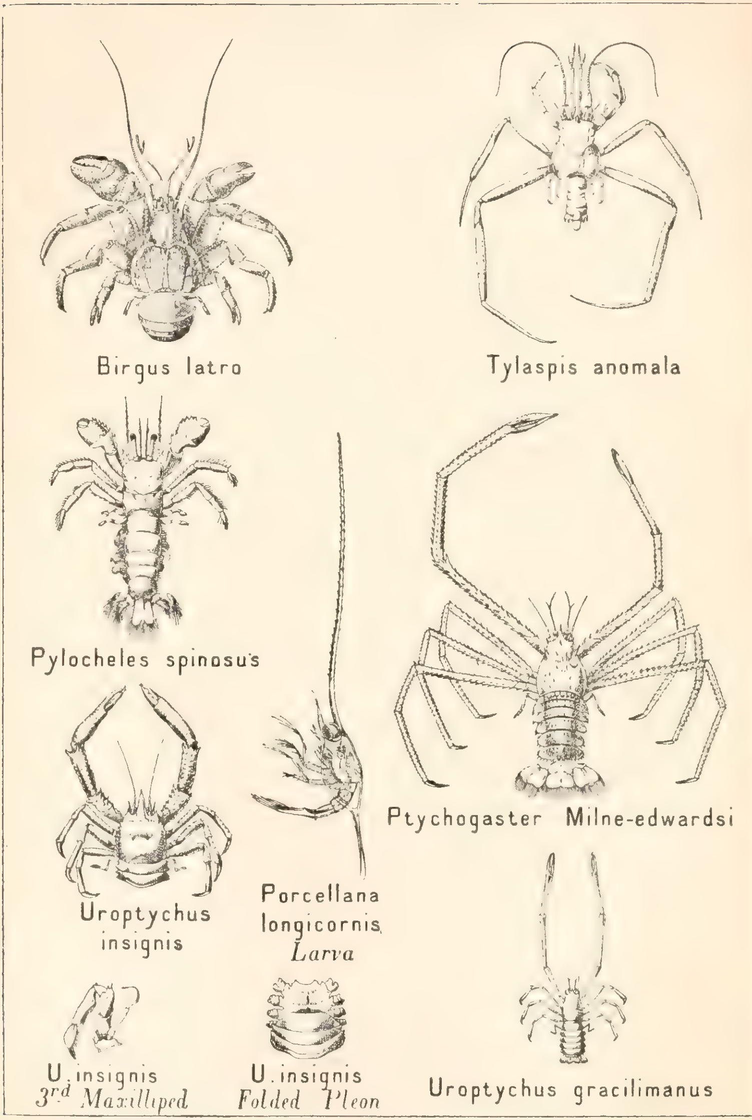
The species are marine and confined to deep water. There are six genera. Dr. Henderson says :—'In all, the gills are modified trichobranchiæ, each consisting of a central stem which gives rise to two collateral rows of rounded filaments, gradually decreasing in size towards the apex, whereas in the Paguridæ the stem gives rise to two rows of flattened leaflets.'

Parapagurus, S. I. Smith, 1879, is typical of the advances made in recent years in submarine science, since a genus so lately known now includes six species, together covering in their range the whole breadth of ocean between 40° north latitude and 45° south. The genus agrees with *Eupagurus* in having the third maxillipeds widely separated

at the bases, the chelipeds very unequal, and the eleven pairs of branchiæ distributed in couples to the third maxillipeds and three following appendages, while the fourth pair of legs have the three remaining pairs of branchiæ. But it differs from *Eupagurus* as well in the structure of the branchiæ as in having well-developed pairs of male appendages on the first and second segments of the pleon. The type species, *Parapagurus pilosimănus*, Smith, has a great range in depth, since American dredging expeditions have taken it at thirty or forty stations in the Atlantic between deeps of 250 to 2,221 fathoms. Low down in the ocean a species may be prolific, for at 319 fathoms nearly four hundred specimens were taken at once.

Notice has often been taken of the curious habit which *Eupagurus Prideaux* has of associating itself with the sea-anemone, *Adamsia palliata*. Surmises are sometimes made as to the advantages which the companions may hope to obtain from the alliance. The anemone may obviously obtain a greatly increased range for supplies of food, by the superior locomotive powers of the hermit, and though the weight of both anemone and shell may seem an unnecessary encumbrance to the crustacean, that objection is gradually diminished by the circumstance that the anemone in course of time almost entirely absorbs the shell. On the other hand the presence of the anemone may be a very valuable protection to the hermit, since numerous fishes are in the habit of swallowing these recluses, shell and all, merely spitting out the shell after they have digested its inmate. But it is most probable that to many fishes an *Adamsia palliata* would be by no means an agreeable morsel, even when flavoured with crab-sauce. It is also not unlikely that the anemone may contribute to the commissariat by throwing out its darts as some swift gliding shrimp passes by, and thus reducing it to a condition in which it can be captured by the pagurid. This alliance, however, which is so familiar, is very far from being the only one in this legion of the Crustacea. Rather it may be regarded as a well-known example of a very prevalent habit. Thus upon shells containing *Eupagurus pubescens*

the *Epizoanthus americanus* fixes itself. First a single polyp finds lodgment, and as its basal membrane spreads over the shell, buds arise from it forming fresh polyps, and gradually this same membrane absorbs the shell though retaining its spiral shape. In this absorption there is a great advantage to the hermit, because as it grows its increase of bulk still finds room in the yielding polyp-mass, without any necessity arising for a change of domicile. In the case of *Catapagurus Sharreri*, A. Milne-Edwards (see Plate IV.), there is sometimes a triple alliance, for over a colony of *Epizoanthus americanus* there settles itself the single polyp *Adamsia sociabilis*. The numerous specimens of *Parapagurus pilosimanus* that were taken in depths reaching to six or seven hundred fathoms were found only in colonies of *Epizoanthus paguriphĭlus*, but those that were taken at much greater depths 'were either in a very different species of *Epizoanthus*, in naked gastropod shells, or in an actinian closely resembling, if not identical with, *Urticina consors*, Verrill.' Dr. Carl Aurivillius has recently published very interesting observations on the 'Symbiosis' or living together of Hydroids, Sponges, and Pagurids. *Hydractinia echinata* is frequently found coating the outside and inside of various shells that are occupied by Hermit-crabs. The mode of growth is such that the hydroid not only repairs in effect the damaged mouth of a shell, but also frequently extends its boundaries. This is especially the case in districts where shells are few, and where the growing Pagurid might be put to much inconvenience to find a larger lodging. By the extension of the hydroid colony, which sometimes gives a quite monstrous appearance to the shell, the hermit is saved the trouble of making any change of abode. The hydroids are saved from the danger and damage they would be exposed to from the rolling about of an empty shell. On the inside of it they do not develop any of the nutritive polyps which might incommode the hermit and also suffer injury from its movements, but they line the interior with a network, to the satisfactory smoothness of which the hermit itself contributes. It might be supposed that this was effected by


Birgus latro
Tylaspis anomala
Pylocheles spinosus
Ptychogaster Milne-edwardsi
Uroptychus insignis
Porcellana longicornis Larva
U. insignis 3rd Maxilliped
U. insignis Folded Pleon
Uroptychus gracilimanus

the friction of its body, but Aurivillius shows that there is a secretion from glands in the sides of the carapace adapted for the purpose, and that the joints in the fourth and fifth pairs of legs of *Eupagurus* are nicely arranged to assist in distributing the secretion.

Paguropsis, Henderson, 1888, is regarded as holding a unique position among Hermit-crabs, inasmuch as the last two pairs of legs of the trunk are subdorsally placed, and the unpaired appendages of the pleon are on the right side instead of the left. Dr. Henderson observes that 'among the Pagurids generally, the soft abdomen, as a result of its being thrust into a Gastropod shell, the spiral of which is normally right-handed, has assumed a similar curve, and the original right side thus closely applied to the columella loses its appendages.' The two specimens taken at a depth of about a hundred fathoms off Tables Island, were free, but the character of the pleon makes it probable that it was protected in some way. The position of the appendages on the right side might be explained as adapted to some species of Gastropod with a left-handed spiral, but the fact that the pleon is simply bent on itself points to some other kind of dwelling.

Pylochēles, A. Milne-Edwards, 1880, has the carapace completely calcified, the chelipeds equal, the pleon symmetrical and well developed with broad semi-calcareous terga and paired appendages of one kind or another on the first six segments, those of the sixth segment forming with the telson a powerful swimming fin. This remarkable genus is said to form a connecting link between the Paguridæ and Thalassinidæ. The type species, *Pylocheles Agassizii*, A. Milne-Edwards, was dredged by the *Blake* from a depth of 200 fathoms off Barbados, and found in the hollow of a piece of sandstone, the mouth of which was closed by its claws, as the mouth of a shell is by those of of an ordinary hermit. *Pylocheles spinosus*, Henderson, which is depicted on Plate VII., is Australian. Nothing is known about its mode of lodging itself. For this genus Mr. Spence Bate in 1888 established the family Pylochelidæ, which he placed between the Galatheidæ and Thalas-

sinidæ. In the family he only places, besides *Pylocheles*, *Pomatochēles*, Miers, 1879, and a new genus *Cheiroplatēa*, and, as he states that it includes all those paguriform Anomura that are trichobranchiate, he was evidently unaware that the family Parapaguridæ had been already established by Smith for this very purpose. His *Cheiroplatea cenobita* (see Plate X.) from the Pacific is no doubt a remarkable animal, having among other singular characters a chelate extremity to the third maxillipeds. The single specimen is a female with very large but not very numerous ova. Mr. Bate compares it with *Glaucothoë*, Milne-Edwards, which Miers and Bate agree in regarding as only an adolescent form. Considering *Cheiroplatea* in its adult condition as representing a link between *Cenobita* and the trichobranchiate Macrura, Mr. Bate remarks that 'it has an appearance strongly suggestive of its being allied to a *Pagurus* that had failed to obtain a molluscous shell for itself, and had consequently retained some of the macrurous characters of its youthful condition.' Both *Pylocheles* and *Cheiroplatea* recall the earliest post-larval forms observed in the Paguridæ.

Legion 4.—*Porcellaninea.*

The carapace is well developed, broadly ovate, smooth, with the regions faintly defined. The eye-stalks are short and stout, the eyes always pigmented and partially concealed in orbits. The first antennæ are concealed. In the second antennæ the peduncle is directed backwards, its second and third segments are coalesced, the flagellum is long and slender. The third maxillipeds have the third joint broad, the fourth provided with a prominent internal lobe. The chelipeds are broad and often flattened, the first three pairs of walking-legs well developed, the last pair slender and inflexed. The pleon is symmetrical, bent under the trunk, having on the sixth segment a pair of lamellar appendages which with the telson form a swimming fan; also in the male it has a pair of genital appendages on the second segment, and in the female a pair of uniramous

appendages to the fourth, to the fifth, and sometimes to the third segment.

Notwithstanding the brachyuran characteristics this legion is found to be in close affinity with the next, the Galatheinea. Here it is supposed that the pleon has become reduced in size and has lost its importance as an organ of locomotion, owing to the special habits which the animals have adopted. They are found under stones between tide-marks and in shallow water among stones, sponges, and corals. One species has been taken at a depth of 390 fathoms. There is but one family.

Family Porcellanidæ.

The characters of the single family are those of the legion. Eleven genera are assigned to it, most of which were instituted by Stimpson in 1858, and some on very slender distinctions. Only one belongs to British waters.

Porcellana, Lamarck, 1801, has the 'front' dentate, the first joint of the second antennæ much produced, fully reaching the margin of the carapace. The chelipeds have a projecting lobe near the base of the inner margin of the fifth joint, the terminal joint often contorted. The walking-legs have the terminal joint short and robust, ending in a single claw. To this genus belong the only British species of the family, *Porcellana platychēles* (Pennant) and *Porcellana longicornis* (Linn.), both of which are common under stones, along which they slidder with some rapidity. They will sometimes flatten themselves against the upturned stone, remaining quiet and evidently trying to look as if they were not there. Quite after the fashion of their kindred, the Galatheidæ, they will lift up their claws to resist attack, but their flattened habit of body makes this posture of defence in their case ridiculously ineffective. If one of the threatening claws be seized, they pretty readily relinquish it and skurry away. To understand the likeness between these crustaceans and the Galatheidæ it is necessary to flatten out the pleon of

the *Porcellana* and so institute a comparison. The zoea of *Porcellana longicornis* (see Plate VII.) has not unfrequently been studied, and the reality of its connection with the adult

FIG. 15.—*Porcellana longicornis* (Linn.), an early post-larval form [Stebbing].

form need not be doubted, but the extraordinary difference between the one and the other can scarcely fail to surprise any one who for the first time compares them. It is strange that the smooth circular carapace of the grown-up Porcellana should result from a larval form in which the

dorsal shield has two long horns behind and one of portentous length in front. Even after the general appearance of the adult has been assumed, the young crustacean shows several interesting differences from its elders. The accompanying figure of a little one, an eighth of an inch long, taken off the back of its mother, exhibits a carapace with numerous little spines not found in the parent, and the telson simply ovate, instead of being subdivided by sutures into seven portions. *Porcellana Robertsoni*, Henderson, is remarkable as having been taken not in shallow water, but at a depth of 390 fathoms in the West Indies. Dr. de Man states that 'the genus *Porcellana* is represented in the Bay of Bengal by no fewer than fifteen species.' Several of them, however, as he explains, belong to the other genera of this family, which Dr. de Man retains as subgenera.

Petrolisthes, Stimpson, 1858, has the 'front' undulated, the first joint of the second antennæ remarkably short, not reaching the margin of the carapace, the fifth joint of the chelipeds often dentate on the inner margin, and the walking-legs as in *Porcellana*. Among the Crustacea collected on Napoleon's celebrated Egyptian expedition, a species, beautifully and elaborately figured by Savigny, was named *Porcellana Boscii* by Audouin, to whom the French Government entrusted the task of describing the species in Savigny's splendid work, in consequence of the latter author's long-continued illness. This species was transferred by Stimpson to his genus *Petrolisthes*, and it well exhibits the unusual prominence which in this family is often assumed by the third maxillipeds, projecting as if they were a powerful pair of feathered antennæ. The name of the genus meaning 'rock-slider' points to one of the characteristic habits of the family.

Porcellanella (White), Stimpson, 1858, differs from *Porcellana* chiefly in having the last joint in the walking-legs not simple but multiunguiculate. Between these two, and agreeing with *Porcellanella* and *Polyŏnyx*, Stimpson, in the multiunguiculate joint, the Russian writer Czerniavsky has insinuated his genus *Porcellanides*, 1884, in his

work on the Decapod Crustacea of the Black Sea. The book, which is more in Latin than in Russian, contains a wealth of bibliographical information.

Legion 5.—*Galatheinea.*

The carapace is elongate, the regions well defined and usually rugose, with a prominent and acute rostrum. The eyes are placed in very incomplete orbits, the eye-stalks short and stout. The first antennæ are exposed. The peduncle of the second antennæ is directed forward and generally has the second and third joints coalesced; the flagellum is long and slender. The third maxillipeds are subpediform, with the third and fourth joints narrow and often spinous within. The chelipeds and walking-legs are often elongate and slender; the last pair of legs are feeble and inflexed. The sterna of the trunk are broad. The pleon is broad and well developed, simply bent, or folded on itself, never adpressed to the trunk. In the female the second to the fifth segments have each a pair of simple and slender ovigerous appendages, those of the second and fourth sometimes rudimentary. In the male the pair of accessory genital appendages of the first segment are well developed, rudimentary, or absent; those on the second segment are well developed; the short, usually flattened pair of appendages on each of the next three segments, are well developed or rudimentary. In one genus the male is destitute of appendages on the first five segments. In both sexes the appendages of the sixth segment and the telson form a swimming fan that is usually powerful. The number of branchiæ, so far as is known, is generally fourteen pairs in this and the preceding legion. There is only one family.

The proximity which is now accorded to the three legions, the Pagurinea, Porcellaninea, and Galatheinea, in spite of external unlikeness, is confirmed, as M. Jules Bonnier observes, in a very interesting indirect manner by the circumstance that Bopyrids of the same genus *Pleurocrypta* occur in all three.

Family Galatheidæ.

The characters are those of the legion. About ten genera are included, two of which—*Galathea* and *Munida*—belong to the British Fauna, and, according to Dr. Henderson, have many species inhabiting shallow water. With the exception of one doubtful genus, the remainder are as yet known only from deep water, and it must be said that according to Dr. Henderson's own report, only a few out of the species of *Munida* come from small depths, some going down to more than 2,000 fathoms, and the majority being taken most abundantly at depths varying from 100 to 300 fathoms.

Galathēa, Fabricius, 1793, has the carapace usually free from spines, except on the anterior gastric area, but furnished with furry transverse striæ. The rostrum is flattened, rather broad, generally having teeth on the margins. The segments of the pleon are unarmed. There are numerous species occurring at very varied depths. They swim backwards with activity, and Mr. Couch states that it is very remarkable to witness the accuracy with which they will dart backward for several feet into a hole very little larger than themselves, an acrobatic performance which he had often seen carried out, and always with precision. There are five British species, all of which occur also on the coasts of France, where they have been studied and described very carefully by M. Jules Bonnier. He supplies a very useful key to discriminate them, depending partly on the shape of the third maxillipeds, and partly on the presence or absence of an epipod in the limbs of the trunk. The epipod, it will be remembered, is the branch which issues from the basal joint of an appendage. In *Galathea squamifera*, Leach, *Galathea nexa*, Embleton, and *Galathea dispersa*, Spence Bate, there are epipods to the chelipeds and the two following pairs of limbs; in *Galathea intermedia*, Lilljeborg, there are epipods to the chelipeds, but not to the following pairs of limbs; in *Galathea strigosa*, Fabricius, there are no epipods to any of the three

pairs. The third maxillipeds in *squamifera* have the third joint shorter than the fourth, in *nexa* equal to it, in *dispersa* longer than it. By this simple combination all the five species are neatly distinguished. The sexes of *Galathea* often show a considerable difference in the chelipeds, those of the male being the longer. In *Galathea squamifera*, the two last joints of the chelipeds in the female touch all along the inner margins of the chelæ, whereas in the male they stand apart, and have a peculiar curvature, meeting only at the apices. This is so pronounced a feature that it misled Spence Bate into establishing a separate species, which he called *digiti-distans*, meaning 'with the fingers wide apart.' *Galathea magnifica*, Haswell, an Australian species, only half an inch long, appears to make up for diminutive size by its striking appearance. The description of it says, 'Colour bright red, with a brilliant purple stripe down the centre of the carapace; legs ornamented with transverse bands of darker red and purple; fingers dark reddish brown, yellow at the tips.'

Munĭda, Leach, 1820, nearly resembles *Galathea*, but is distinguished by having a slender stiliform rostrum, and the supraorbital spine on each side of its base not small but well developed. Moreover, in general, the carapace has a spinulose surface, and its cardiac region distinct, and the pleon has one or more segments with a series of spinules on the anterior dorsal margin. The chelipeds and walking-legs are elongate and slender. The type species *Munida rugosa* (Fabricius, 1775) is distributed over all the seas of Europe. The very long chelipeds make it conspicuous. The third maxillipeds have the third joint longer than the fourth. The chelipeds and ambulatory legs are without epipods. It is not to be met with in shallow waters. Bell, on insufficient grounds, altered the name to *Munida Rondeletii*. Though the old naturalist Rondelet well deserved honour, this was not the right way to pay it. It may be noticed, however, that G. O. Sars, writing in 1889, speaks of *Munida Rondeletii*, Bell, and *Munida rugosa* (Fabricius) as two distinct though

closely allied species. In 1882 he had explained that Bell's *Munida Rondeletii* was distinguished from the other species by its very small eyes, not furnished with a circlet of hairs, and by the complete want of the two dorsal spines on the third pleon-segment. But Bell gives another specific character, 'second and third segments of the abdomen, the former with six, the latter with four small spines on the anterior margin; the other segments without spines.' In two specimens from the Clyde, both having circlets of hairs to the eyes, the pleon has on successive segments, in one case, six, four, and two spines, but in the other six and four and none.

Grimothea, Leach, 1820, established to receive the *Galathea gregaria* of Fabricius, is still in an uncertain position, it being supposed by some that the species is a young form of *Munida subrugosa*, Dana.

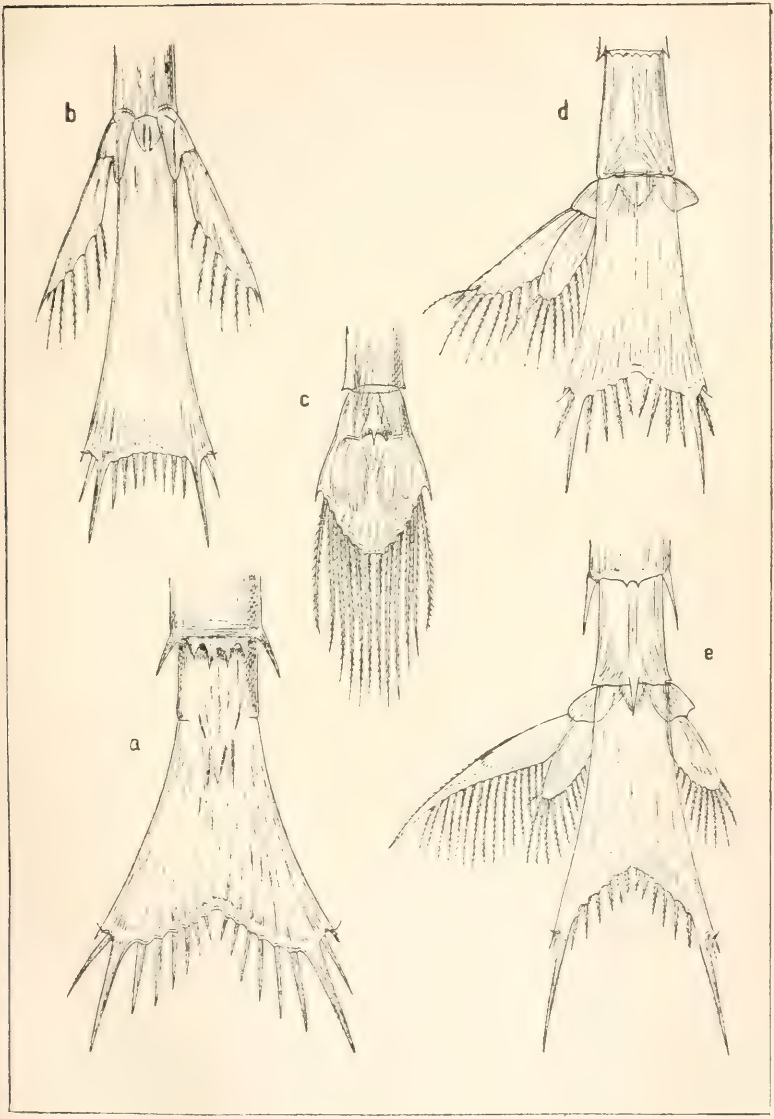
Munidopsis, Whiteaves, 1874, has eyes devoid of pigment, and the stalk of the eye frequently prolonged beyond the cornea in the form of a spine or spines. The species are found in depths varying from 100 to more than 2,000 fathoms. 'It is probable,' Dr. Henderson remarks, 'that the loss of sight is compensated by a greater development of the tactile sense, and in some species this is evidenced by the great length of the antennal flagella, which in all probability enable the animal to grope its way about on the bottom.' The eggs are few and large, as is often the case with the ova of deep-water species, which are supposed to find their advantage in passing through several of their metamorphoses within the egg, so that the young one is hatched in a form nearly like that of the parent.

Eumunida, S. I. Smith, 1883, occupies an exceptional position, for the peduncle of the second antennæ has five distinct joints, the third maxillipeds are without the usual two pairs of rudimentary arthrobranchiæ, and the pleon of the male is without appendages on the first five segments. The type species, *Eumunida picta*, Smith, was taken in the North Atlantic.

Uroptychus, Henderson, 1888, is the equivalent of

Diptychus, A. Milne-Edwards, 1880, the name *Diptychus* being pre-occupied. Of the species *Uroptychus insignis*, Henderson, and *Uroptychus gracilimănus*, Henderson, figures are given on Plate VII. In this genus the second antennæ have on the second (the first free) joint of the peduncle an acicle, thus differing from all the rest of the family, except *Eumunida*, in which one is also present, though of very small size. Dr. Henderson says:—'In those species which I have examined, the fifth arthrobranchia, counting from before backwards, is not of larger size than the others, whereas in most of the Galathodea it is distinctly enlarged.' According to M. Jules Bonnier, in the species *Uroptychus rubrovittatus* (A. Milne-Edwards) there are no arthrobranchiæ, their places being taken by a corresponding number of pleuro-branchiæ—that is, by branchiæ inserted on the pleura or sides of the segments, instead of being placed on the articulating membranes that unite the appendages to the segments. In this genus, and in *Ptychogaster*, A. Milne-Edwards, 1880, and in *Eumunida*, there is a comparative weakness of the swimming-fan, which probably for that reason is twice folded on itself. The members of these genera being sometimes found in the branches of Gorgoniæ, it is conjectured that they lead a sedentary life, that the swimming-fan is in consequence losing its importance, and an advance is thus being made towards the brachyuran type. *Ptychogaster Milne-Edwardsi*, Henderson (see Plate VII.), from Patagonia, has the pleon, except the telson and uropods, covered with rows of short stout spines.

The larval development in species of the genera *Lithodes*, *Eupagurus*, *Anapagurus*, *Munidopsis*, *Galathea*, *Munida*, and *Porcellana*, has been carefully studied by G. O. Sars, and his results confirm from this point of view the close union of the legions to which these genera respectively belong, as well as the propriety of including the whole group among the Macrura. From Sars' work on this subject have been borrowed the figures grouped together on Plate VIII., representing the end of the pleon in the last larval stage respectively of *Lithodes maia*



End of Pleon in the last larval stage

a. Lithodes maia (Linn.). b. Eupagurus Bernhardus (Linn.). c. Porcellana longicornis (Linn.). d. Galathea intermedia, Lilljeborg
e. Munida rugosa (Fabricius)

(Linn.), *Eupagurus Bernhardus* (Linn.), *Porcellana longicornis* (Linn.), *Galathea intermedia*, Lilljeborg, and *Munida rugosa* (Fabricius).

It will be remembered that the larval forms of Crustacea often show not the smallest resemblance to the adults, and also that it is extremely difficult to breed in confinement those which pass through many transformations from the egg to the perfect condition. In this interval at every moult, the shedding of the skin is attended with danger. The movement, the saltness, the temperature, of the water in which they are kept should correspond with the conditions they would have experienced in their proper marine home. When all this has been suitably cared for, the supply of appropriate food must be considered, and this will probably not be the same for all the stages. When several specimens occupy a common nursery the more advanced are very apt to destroy the less forward, and the creatures being as a rule very small there are risks of confusions, the larvæ of distinct species being perhaps mistaken for the stages of one and the same species. In calm weather, and, at least, in the latitude of Great Britain, especially, though not exclusively, after dark in the months of August and September, it is easy in many parts of the sea by means of a surface-net to obtain an abundance of larval forms, but there is a great difficulty in determining the species and genera to which they severally belong. Being minded to connect together the several stages of a crustacean's life with some approach to certainty, Professor Sars made a practice of carefully drawing and dissecting the forms he met with, and then by comparison of a long series he was able in numerous instances to assign them in proper sequence to species of which the adults were already known. Considering the vast numbers of the Crustacea, it is evident that there is valuable work to be done on these lines, enough to occupy a crowd of zoologists for many years to come, and the plan is available for many who have no access to the constantly improving resources of the modern scientific aquarium or marine biological station.

CHAPTER XII

TRIBE II.—THALASSINIDEA

The carapace is short and compressed, with little or no rostrum. The last segment of the trunk is articulated with the preceding. The eye-stalks are small. Both pairs of antennæ have long peduncles. Of the trunk-legs the first pair are perfectly or imperfectly chelate, the last pair are short, more or less abnormal, directed backwards. The pleon has the segments not overlapping, with the side-plates feebly developed and having their hinder angles generally rounded. The pleopods are long, biramous, variable; the swimming fan is strong. The branchiæ vary in number and form.

In this tribe are included four families, the Thalassinidæ, Callianassidæ, Axiidæ, and Thaumastochelidæ. The division of the Macrura adopted by the late Mr. Spence Bate, into Trichobranchiata, in which the branchial plumes are made up of long cylindrical filaments, Phyllobranchiata, in which the plumes are formed by a series of foliaceous plates, and Dendrobranchiata, in which the branches of the various plumes divide and subdivide in an arborescent manner, does not seem practically very convenient. It has been already seen that two families so intimately allied as the Paguridæ and Parapaguridæ would have to be placed, the former in the Phyllobranchiate, the latter in the Trichobranchiate, division. But also in the present tribe Spence Bate himself points out a weakness in the arrangement, for of the genus *Callianassa* he says:—‘The structure of the branchiæ of *Callianassa* is so intermediate in character that it may be claimed by anatomists as be-

longing to either the Phyllobranchiata or to the Trichobranchiata, as the plumes consist of two rows of long slender filaments so closely impacted together that they are flattened into plates,' and elsewhere he remarks that 'in some genera, as in *Thalassina*, the branchiæ are both foliaceous and filamentous.'

Family 1.—*Thalassinidæ.*

The carapace is dorsally flattened, with rostrum. The eyes are small, the eye-stalks cylindrical. The first pair of antennæ have the flagella long; the second have no scale on the second joint. The first pair of trunk-limbs are unequal, imperfectly chelate, the last joint or finger being longer than the thumb; the four following pairs are simple, with the terminal joint long. In the pleon the uropods, that is, the appendages of the sixth segment, are slender and acute, the outer branch not transversely sutured; the telson is also without suture, obtusely pointed. The branchiæ are complex.

The family includes but one genus.

Thalassina, Latreille, 1806, has the characters of the family. It contains but few species, perhaps only the type *Thalassina anomalus* (Herbst, vol. 3, part 4, p. 45, 1804), which Latreille in 1806 called *Thalassina scorpionoides*. This is widely distributed in the Pacific. A specimen nine inches long was procured by the *Challenger* at Kandavu, one of the Fiji Islands. Some points of Mr. Spence Bate's minute description will teach the student what to look for in various other species of the Macrura. For the small sub-conical eyes imperfect orbits are formed by help of the rostrum and depressions in the upper surface of the first antennæ. Projecting forwards from the rostrum and upper part of the orbit and backwards from the antennæ are numerous hairs which form for the eyes a protecting fringe, which is in Greek the *blephăris*, in English the eye-lashes. The basal joint of the first antennæ has a long triangular slit, the opening of the ear, which is thus described:—'The auditory apparatus consists of a large

calcareo-membranous chamber, attached to the upper wall of the antennæ. Around the orifice that opens into it, within the chamber, there is a curved row of closely planted delicately ciliated hairs, each of which is attached to the base by a flexible membranous articulation, from which it proceeds flattened and tolerably broad for more than half its length, when it narrows rapidly and becomes ciliated, the cilia being short and fine; the hairs extend nearly if not quite across the auditory chamber, the floor of which is covered with small points, while the cavity contains much angular calcareous sand. This I found mostly gathered into a compact mass, but most probably when the animal was in a living condition it was not so, being then kept in a state of motion by the aid of the long slender ciliated hairs that have just been described.' In discussing the peculiar combination of slender filaments and flattened plates in the branchiæ of this crustacean, Mr. Spence Bate observes:—'In a respiratory chamber, such as in the genus now before us, the water flows in by the posterior extremity, for which purpose the carapace can be raised or depressed at will within certain limits; and as we may assume that in a large chamber such as the present, the water flows along the lower margin, passing out at the anterior end only, it is probable that the largest amount of current will correspond with that portion of the chamber where the trichobranchiate filaments are best developed and most abundant, whereas the phyllobranchial plates are present in the centre and deeper recesses of the chamber, where the circulation will be more quiescent, and the power of oxygenation less efficient.' As there is reason to suppose that the animal may inhabit hollow passages in the mud, where the circulation of water through the branchial chamber would not be very vigorous, and least so in the part most distant from the direct current, Mr. Spence Bate infers that in the central portion of the chamber the branchiæ have been developed into thin foliaceous plates of considerable dimensions, so that through the tenuity of their structure the blood may be brought over a large surface into contact with the aerating medium within the chambers.

Family 2.—Callianassidæ.

The carapace is laterally compressed, with rostrum minute or absent. The eyes and antennæ are as in the preceding family. The first pair of trunk-limbs are unequal, perfectly or imperfectly chelate, the third and fourth pairs simple, the others variable. The uropods and telson are usually broad, without sutures. The branchiæ are filamentous, with the filaments sometimes compressed.

Six or seven genera are assigned to this family, of which two are British.

Callianassa, Leach, 1814, was instituted to receive a species which Colonel Montagu described in 1805 (and published in 1808) under the name *Cancer Astacus subterraneus.* He found it at the depth of nearly two feet beneath the surface, while digging into a sandbank in the estuary of Kingsbridge or Salcombe in South Devon. Though it was by no means plentiful, he ascertained that the larger arm was not constant to one side, and that the extreme disproportion sometimes exhibited by it was not invariable. The crustaceous covering of the body he describes as 'very thin and not far remote from membranaceous.' The exceedingly narrow attachment between the first four joints of the larger cheliped and the following three which form its monstrous termination give to this species a very peculiar appearance. The second pair of feet are minutely chelate. The second pair of pleopods are slender and filamentous, while the following three pairs are broad and foliaceous. A. Milne-Edwards in 1870 distinguishes seventeen recent species. Czerniavsky in 1884 points out that the Mediterranean *Callianassa laticauda*, Otto, should be added to the list.

Callianassa Stimpsoni, Smith, is a species found on the east coast of the United States. This and other deep-burrowing crustaceans are more often obtained from the stomachs of fishes than by intentional methods of capture.

Cherămus, Spence Bate, 1888, was instituted chiefly

on account of the contradictions in different writers in regard to the third maxillipeds of *Callianassa*, some calling them pediform, others operculiform. In *Cheramus* they are distinguished as pediform, but it seems rash to establish a new genus on the very character which some authors ascribe to the old one, especially as *Callianassa* is not unrepresented in England, France, and the Mediterranean, and specimens might have been examined to clear up the disputed point. In the British Museum Leach's type-specimens of *Callianassa subterranea*, from Kingsbridge in South Devon (Salcombe at the mouth of the Kingsbridge estuary being probably intended), have third maxillipeds that might well be described as pediform. But other specimens at the same museum, which have been labelled as belonging to the same species, were shown me by Mr. Pocock, and in these, which came from Jersey, the third and fourth joints of the maxillipeds in question are greatly expanded, quite deserving the name operculiform. But these specimens also have a more quadrate telson than those from Devonshire, and are doubtless quite distinct. Since, however, in the type of *Callianassa* the maxillipeds are pediform, the chief reason for the institution of *Cheramus* is cut away. Its name signifies 'a gap,' but it has not succeeded in filling one.

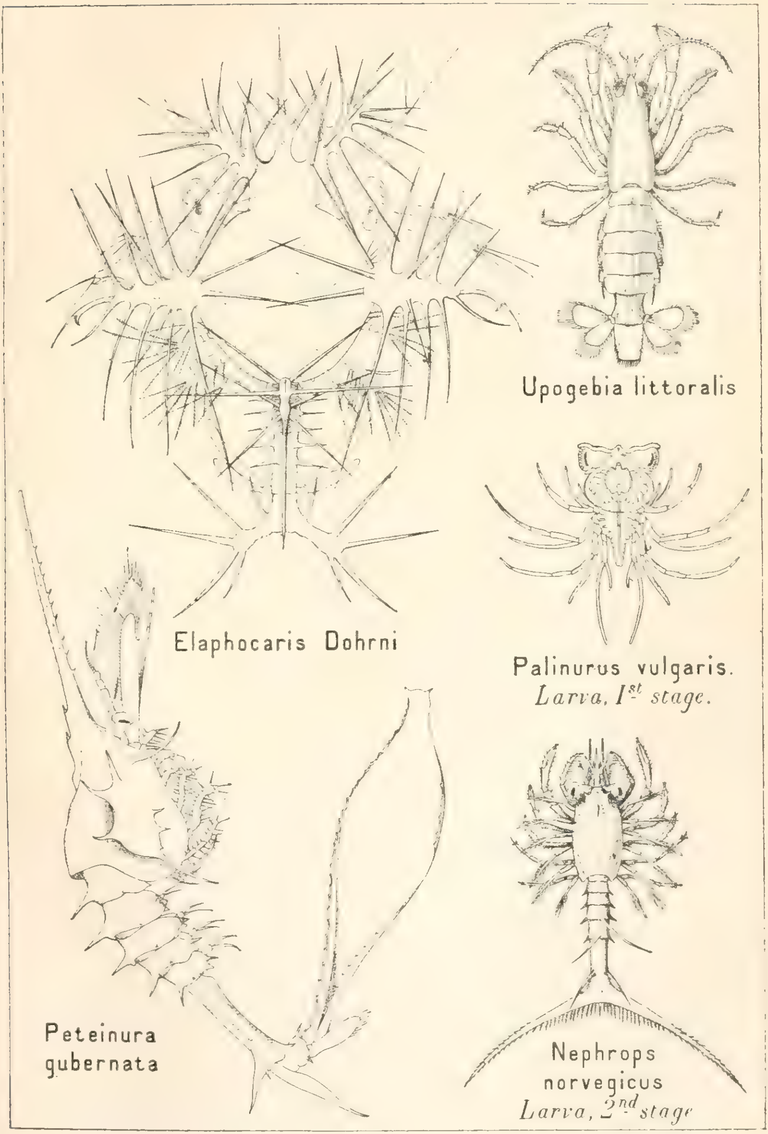
Callianidea, Milne-Edwards, 1837, closely resembles *Callianassa*, but with some differences in the branchial arrangements, and, besides having the second pleopods like the following three pairs, in all these pleopods 'the margins, instead of being fringed with small hairs or cilia, have these modified into soft and flexible articulated membranous filaments.' Milne-Edwards supposed that these were true branchial appendages, and that a link was thus established between this family and the Squillidæ in the sub-order Stomatopoda. With his own genus he coupled Guérin's *Isea*. But Mr. Spence Bate regards it as probable that Guérin's genus was founded on a damaged specimen of *Callianidea*, and with some reason thinks that the fringed pleopods of that genus cannot be regarded as branchial for purposes of classification.

Upogebia, Leach, 1814, was founded to receive another species discovered by the industrious Montagu, and described by him in 1805 (1808) as *Cancer Astacus stellatus*. The colour, he says, is 'yellowish-white, covered with minute stellated orange spots, as it appears under a lens, which give a predominance to the last.' In this genus the first pair of legs are subequal and subchelate, the other pairs being simple; the second pair of pleopods is like the three following pairs, with the margins strongly ciliated; the components of the swimming fan are broad-ended. It seems to have escaped the notice of writers subsequent to Leach that the earliest name of this genus was *Upogebia*, which must therefore be retained in preference to Leach's own alteration of it into *Gebia*, or Risso's *Gebios*. Bell refers to the 'Edin. Encycl., xi. p. 400,' as an authority for *Gebia stellata*, printing xi. by mistake for vii., and probably guessing at *Gebia* by mistake for the actual *Upogebia*.

The type species was taken along with the type of *Callianassa*. On the nearly allied American species described by Say, Verrill and Smith make the following observations:—'The *Gebia affinis* is a crustacean somewhat resembling a young lobster three or four inches in length. It lives on muddy shores and digs deep burrows near low-water mark, in the tenacious mud or clay, especially where there are decaying sea-weeds buried beneath the surface. The burrows are roundish, half an inch to an inch in diameter, very smooth within, and go down obliquely for the distance of one or two feet, and then run off laterally or downward, in almost every direction, to the depth of two or three feet, and are usually quite crooked and winding. We have found them most abundant on the shore of Great Egg Harbour, New Jersey, near Beesley's Point, but they also occur at New Haven and Wood's Hole, &c. This species is quite active; it swims rapidly and jumps back energetically. It is eagerly devoured by such fishes as are able to capture it. When living the colors are quite elegant. Along the back there is a broad band of mottled, reddish brown, which is contracted on the next to

the last segment; each side of this band the mottlings are fewer, and the surface somewhat hairy. The last segment and the appendages of the preceding one are thickly specked with reddish brown; their edges are fringed with grey hairs.' Leach's statement that *Upogebia stellata* makes winding horizontal passages in the mud, 'often of a hundred feet or more in length,' appears still to await confirmation.

A second British species was named *Gebia deltāura* by Leach, on the ground that the interior lamella of the tail-fan is 'truncate and formed like the Greek Delta.' No doubt he was alluding to the inner branch of the uropods. This is an obscure feature on which to base the specific name, and Bell has been not unnaturally misled into supposing that Leach was referring to the telson, which, however, is not at all deltoid in form, and which Leach himself expressly describes as 'quadrate' and 'nearly quadrate.' According to Leach 'this species lives with *G. stellata*,' and Bell suggests that it is probably identical with it. The Mediterranean '*Gebios littoralis*,' Risso, is a nearly allied species, which ranges to the coast of Norway, and may therefore be expected to occur in intermediate waters. The name *Gebia* no doubt signifies 'life in the ground,' and *Upogebia* 'subterranean life,' in allusion to the burrowing habits which make specimens of the genus rare. The young ones, however, may be taken pretty plentifully at the surface, and Sars has in consequence been able to describe the first larval stage or Zoea-form, the second or transition from Zoea to Mysis stage, the third or Mysis-form, the last larval stage, and the first post-larval stage of adolescence (see Plate IX.) From these descriptions it will be seen, he observes, that *Gebia* in some respects is very distinct from *Nephrops* and *Calocāris*, two of the genuine Macrura which he had previously been examining, as well as from all the Carides, while in several points of development it approaches the Anomura. In the Carides as in *Calocaris* the rule appears to be that the first larval stage or Zoea form is characterised by the presence of three pairs of well-developed swimming appendages, representing the exopods


Elaphocaris Dohrni
Upogebia littoralis
Palinurus vulgaris.
Larva, 1st stage.
Peteinura gubernata
Nephrops norvegicus
Larva, 2nd stage

on the three pairs of maxillipeds, while the endopod of the last pair of maxillipeds is fully developed, distinctly articulated and setiferous. On the other hand in *Gebia*, or, to give it its right name, in *Upogebia*, as in the Brachyura and Anomura, this last pair of maxillipeds is entirely undeveloped in the first larval stage, the exopod or swimming branch being developed later on, but the endopod remaining undeveloped during the whole larval life. But again from both Brachyura and Anomura the larva of *Upogebia* is distinguished, because, just as in the Carides, a real Mysis-stage is passed through, in which not merely the three pairs of maxillipeds, but also the first three pairs of trunk-limbs are furnished with swimming-branches. As to the intimate structure of the maxillipeds and mouth-organs generally, Sars remarks that the larva of *Upogebia* shows a very striking likeness to the larvæ of certain Anomura, for example, *Galathea*.

The *Jaxea nocturna*, Nardo, 1847, which Heller in 1856 called *Calliaxis adriatica*, may belong to this family, but the rostrum is well marked.

Family 3.—Axiidæ.

The carapace is produced to a horizontally flattened point or rostrum. The first pair of trunk-legs are chelate and subequal; the second pair are small, chelate, equal; the last three pairs are simple. The first segment of the pleon is very short. The outer branch of the uropods is not longer than the inner. The branchiæ are filamentous, cylindrical, and compressed. The family contains three genera, one of them British.

Axius, Leach, 1815, has for type species *Axius stirynchus*, Leach, first found at Sidmouth. Norman says that this species has 'the telson quadrangular, the hands smooth, the fingers channelled, the particular articulation of cephalothorax and abdomen described by Mr. Couch, and the transverso-lateral tufts of hair on the abdominal segments.' He supposes that Leach and Bell, in attributing an elongate-triangular form to the telson, were misled by

the appearance of a dried specimen. Spence Bate declares that '*Axius* has been taken only on the southern coast of England,' but Bell and Marion have reported it from the Mediterranean and Milne-Edwards from the coasts of France. The name of the species may be guessed to signify 'with a stiff rostrum.' The same feature belongs to a second species, *Axius glyptocĕrus*, von Martens, found in Australian waters. The second antennæ in this genus have a movable spine or scale representing the exopod on the second joint.

Paraxius, Spence Bate, 1888, was founded for a species taken off Celebes Island, in which the second antennæ have no 'scaphocerite,' that is, no scale, spine, or other representative of the exopod on the second joint, and no 'stylocerite.'

Eiconaxius, Spence Bate, 1888, has three species, all taken from depths of some hundreds of fathoms in the Pacific. Here the second antennæ have 'the peduncle furnished with a scaphocerite and stylocerite.' 'This genus,' the author says, 'differs from *Paraxius* in having both scaphocerite and stylocerite, which are absent in that genus; this character also separates it from *Axius*. which has a small scaphocerite only. The stylocerite, which is present in this genus, is wanting in *Axius*, as it is in all the Macrura, except *Eiconaxius* and *Cheiroplatea*. Its presence is a feature most prevalent in the Anomurous Crustacea.' In the description of the type species, *Eiconaxius acutifrons*, Spence Bate says of the second pair of antennæ, 'its third joint is externally produced to a long sharp tooth or stylocerite.' Yet in his glossary 'stylocerite' is defined as 'style or large spine on outer margin of the first joint of the first pair of antennæ,' and in the Introduction to his Report on the *Challenger* Macrura, he attributes a stylocerite to the first antennæ in species of *Penaeus*, &c., but states that it does not exist in the Trichobranchiata. Under all the circumstances it seems as if it would be just as well to call a spine a spine instead of a stylocerite. The single specimen of *Eiconaxius parvus*, half an inch long, taken from a depth of 520 fathoms, had

seven eggs, which, as so commonly in deep-water species, were extremely large. From one of these Mr. Spence Bate extracted a young animal, and this proved to be not unlike the young of the lobster at the same stage, but more advanced, thus so far confirming the view that the great size of the deep-water ova is in relation to the more than usual advancement of the embryo before it is hatched.

Family 4.—Thaumastochelidæ.

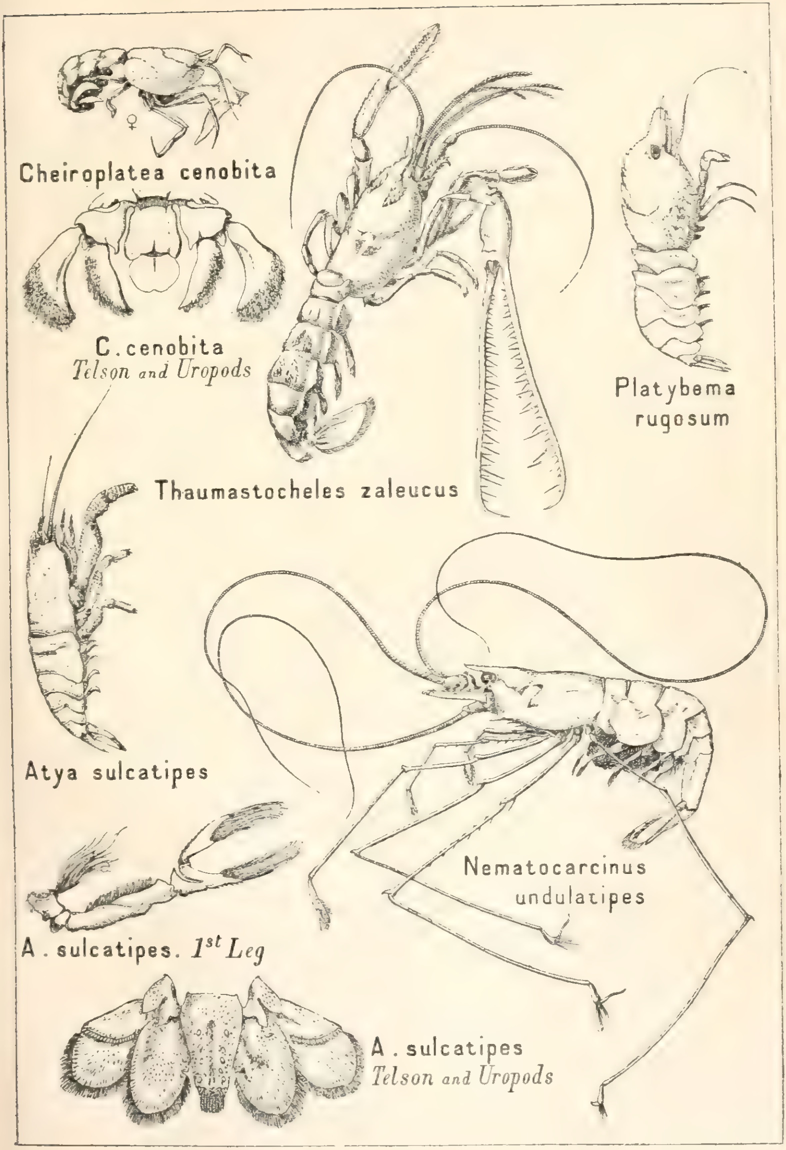
The carapace is produced to a flattened point or rostrum. The first pair of antennæ have on each peduncle two long subequal flagella; the second have a scale or exopod. The first pair of trunk-limbs are chelate, unequal, somewhat unsymmetrical; the small second pair are chelate, subequal, symmetrical; the outer branch of the uropods is larger than the inner. The branchiæ are filamentous, cylindrical.

To this family Spence Bate assigns only two genera, one of which is British.

Thaumastochēles, Wood-Mason, 1874, is appropriately named 'the creature of wonderful claws.' The type species, *Thaumastocheles zaleucus* (von Willemoes Suhm) (see Plate X.), was taken by the *Challenger* from a depth of 450 fathoms in the West Indies, along with a great number of other curious marine animals frequenting the globigerina ooze in that locality. It is blind, and not only without eyes but without eye-stalks, unless perchance the latter are represented by a pair of tubercles projecting from the 'front.' The 'front' is sub-membranous and translucent, and Spence Bate supposes that the optic nerve may terminate so closely behind it as to receive impressions of light. But though there are no eye-stalks, there are excavations in the anterior margin of the carapace corresponding to orbits, and also depressions in the first pair of antennæ such as eye-stalks often rest in. The inference then is clear that eye-stalks once existent have been lost, and this probably from their being detrimental instead of useful to a burrowing creature. The burrowing character is in-

ferred from the general agreement of the species with others that are known to be fossorial. This agreement is exhibited more especially in the tail-fan, but other features favour the notion of such a habit. The flagella of the first antennæ, fringed with long fine hairs, may assist in keeping open a breathing hole. The anterior outlet of the branchial chamber is protected against intrusive particles by a joint of the first maxillipeds so disposed as to serve for an operculum. Of the very unequal first legs the limb on the right side has the thumb and finger monstrously developed into a pair of combs carrying about sixty unequal teeth apiece, and, as Spence Bate observes, 'it appears probable that when partially closed it has the power of raking the neighbourhood to a considerable distance, and so entrapping small animals and other material from which the blind creature has the power of selecting its food.' As this extremely elongate hand could not convey the food to the mouth, the short second and third pairs of legs are also conveniently chelate. The fifth pair are the same, at least in the female, but in these the minute chela buried in a thick brush of fur probably has some function other than that of assisting its mistress to feed.

Calocāris, Bell, 1853, has but a single species, *Calocaris Macandreæ*, Bell, found in the waters of Ireland, Scotland, and Norway. It is still comparatively rare, as might be expected of an animal which burrows at depths of 80 and 150 fathoms. Its habits would seem to be tolerably sluggish, since specimens are sometimes overgrown with a small zoophyte, the polyzoon *Triticella flava*, Dalyell, which can scarcely serve any purpose of concealment. The eyes are present but have lost their pigment, so that vision is probably dim. The first pair of legs are unequal, but not strikingly so. These and the next pair are chelate, while the remaining three pairs are simple. Spence Bate makes it a character of the family that the tail-fan has the outer plates much larger than the inner, but, though this is true of *Thaumastocheles*, it scarcely applies to *Calocaris*.


♀
Cheiroplatea cenobita
C. cenobita
Telson and Uropods
Thaumastocheles zaleucus
Platybema
rugosum
Atya sulcatipes
A. sulcatipes. 1st Leg
Nematocarcinus
undulatipes
A. sulcatipes
Telson and Uropods

CHAPTER XIII

TRIBE III.—SCYLLARIDEA

THE first antennæ carry two flagella; the second have no scale. The trunk-legs are six-jointed through coalescence. The first pair are not much larger than the second, and simple or scarcely subchelate; the three following pairs are simple, and the fifth pair is simple in the male, more or less minutely chelate in the female. The branchiæ are well developed; epipodal plates on the first joint in the first four pairs of trunk-legs have podobranchiæ attached to them as distinct plumes. All these same limbs have arthrobranchiæ, and the last four segments of the trunk have pleurobranchiæ. The first segment of the pleon is without appendages.

In this tribe Spence Bate says that the ova are very small, and that the young are hatched in a *Phyllosoma*-form. With the Astacidea and Stenopidea it forms what he calls the normal group of the Trichobranchiate Macrura. It contains two families, the Scyllaridæ and Palinuridæ, and the tribal name given it by Spence Bate was Synaxidea (see p. 46), derived from a new genus *Synaxes*, which he considered to combine some of the features of both families. As *Synaxes* is itself a synonym, it was not possible to retain the tribal name derived from it, while Heller's term *loricata* adopted by Paulson, Boas, and others, is not in conformity with the names of the neighbouring tribes.

Family 1.—*Scyllaridæ*.

The carapace is depressed, with orbits for the eyes excavated in the dorsal surface. The second antennæ are

short, squamiform. The mandibles have a one-jointed 'palp.' The trunk-legs are simple, except the fifth pair in the female, which are minutely chelate.

To this family there are assigned six or seven genera, one of which is occasionally met with in the waters of Great Britain. In this and other families in which the fifth pair of legs are chelate in the females only, they are supposed to be so constructed to assist in rupturing the ovisac, and liberating the embryo from the ovum. Bell explains the unusual structure of the second antennæ by suggesting that they have been developed into broad flat organs of natation, and probably also constitute a pair of shovels for the purpose of burrowing.

Scyllărus, Fabricius, 1793, has been much subdivided since its first institution. As re-defined by Dana, it has the rostrum very salient, the sides of the carapace not incised, the second antennæ almost contiguous, the exopod of the third maxillipeds ending in a lash; the pairs of branchiæ twenty-one.

In various writers the expression will be found in such definitions as the above, that the *palp* of the third maxillipeds is or is not furnished with a *flagellum*. Now Professor Huxley in 'The Crayfish' says that, in the terms usually applied to the maxillipeds by writers on descriptive zoology, 'the exopodite is the *palp*, and the metamorphosed podobranchia, the real nature of which is not recognised, is termed the *flagellum*.' It must therefore be borne in mind that the *flagellum* mentioned by Huxley as an equivalent to the podobranchia or epipod on the first joint is quite distinct from the *flagellum* of the exopod, the term being used in the latter instance merely to signify a whip-like termination, a many-jointed, more or less flexible lash.

Scyllarus latus (Rondelet), Latreille, is found in the Mediterranean and Atlantic. It is said sometimes to attain a length of a foot and a half, and to be delicious food, superior to the lobster itself. Patrick Browne in his 'History of Jamaica,' calls it 'The Mother Lobster,' and Petiver designates it, 'the great broad warty crab.' In

Savigny's fine folio plate its characteristics are beautifully delineated. The enormously broad ultimate and antepenultimate joints of the second antennæ will astonish and perplex any one who for the first time becomes acquainted with a crustacean of this family. In the present species the quadrangular rostrum, the little eyes very wide apart, and implanted at a little distance from the sharp anterior angles of the great oblong tuberculate carapace, the comparative smallness of the legs entirely unchelate, and the breadth of the tail-fan, are characters which will attract and deserve attention.

Thenus, Leach, 1819, has still only the type species, *Thenus orientalis* (Fabricius), in which the carapace is broader than long, with a bilobed rostrum, and the eyes placed on visible stalks at its anterior angles. There are twenty-one pairs of branchiæ.

Ibăcus, Leach, 1815, has the carapace much broader than long, deeply incised on the sides, with a bilobed rostrum, and the small eyes planted far from the front angles; the broad second antennæ not very remote on their inner margins, the pairs of branchiæ twenty-one or twenty-two. Species of this remarkable genus are distributed all over the Eastern seas, but *Ibacus verdi*, from St. Vincent, Cape Verde Islands, and also from Samboangan in the Philippines, is said to afford the only specimens of the genus taken elsewhere than along the Pacific coasts of Asia and the Australasian Islands. 'Hence,' Spence Bate who instituted the species observes, 'the similarity that it bears to *Ibaccus incisus* (Péron) is the more remarkable, and, judging by the several figures and descriptions published, the differences are slight, except in the character and number of the dentations that arm the margins of the carapace and antennæ.' He also calls attention to the thinning out of the sharp lateral margins to an extent equalling that of some of the Brachyura. Moreover, while the cervical groove, often so conspicuous in the Macrura, is here wanting, the lateral notches are greatly deepened, and widely separate the suborbital and hepatic regions from the branchial. As in

others of this family, the basal joint of the second antennæ is not free, but closely fused with the ventral portion of

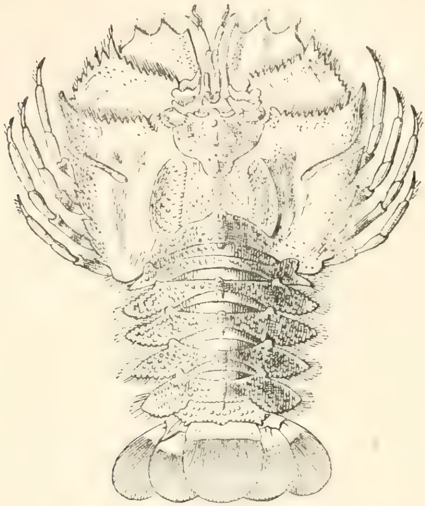


FIG. 16.—*Ibacus incisus* (Péron) [Desmarest].

the head. Spence Bate enumerates twenty-two pairs of branchiæ in this species. Why he changes *Ibacus* into *Ibaccus* he has not bequeathed us any explanation.

Pseudibacus Veranyi, Guérin, may receive a passing mention, as a Mediterranean species.

Arctus, Dana, 1852, has the rostrum very short and truncate, the second antennæ remote from one another, the exopod of the third maxillipeds without a lash, and the pairs of branchiæ nineteen in number.

In the definition of this genus Dana is practically following de Haan in stating that the palp of the third maxillipeds is without a flagellum. Mr. Spence Bate translates this into his own terminology, and speaks of the genus 'having no ecphysis attached to the second pair of gnathopoda,' which would mean that there was no exopod to the third maxillipeds at all. But that is not the case.

The exopod, or 'ecphysis,' or 'palp,' is present, but as de Haan's figure shows, and as his statement declares, the lash-like termination is absent.

It rather looks as if Dana had stolen the type species of *Scyllarus*, on which to found his new genus. At any rate he changed *Scyllarus arctus* into *Arctus ursus*, both in the generic and specific name making allusion to a bear, not because of any resemblance in shape between Bruin and this crustacean, but evidently because of the thick and short pilose substance which protects the tuberculate surface of the latter, and which is said to give it in its perfect condition a smooth velvety appearance, like the shining coat of the bear.

Arctus ursus occasionally makes its appearance in English waters. It is recorded from many parts of the Mediterranean, and also from Australia and Japan. There are several other species of the genus. They do not seem to attain any remarkable size.

Family 2.—*Palinuridæ.*

The carapace is longitudinally subcylindrical, with orbits for the eyes partially excavated. The second antennæ are subcylindrical, with a long rigid multiarticulate flagellum.

Spence Bate assigns to this family five genera, one of which is found in British waters.

Palinūrus, Fabricius, 1797, is restricted by Spence Bate to those species which have a small central rostriform tooth or tubercle that overhangs but does not cover or enclose the ocular segment, which have short flagella to the first antennæ, and in which the segment that carries those antennæ is anteriorly produced and laterally compressed in front. Such species appear to be confined to the northern hemisphere. The type, *Palinurus vulgaris*, Latreille, of which the true specific name is involved in some perplexity, is found in many parts of Europe, including the shores of Great Britain. Bell considers that it is without doubt the *Carabos* of Aristotle. It is a very handsome species, some-

times attaining a length of eighteen inches, and is valued for food, though it has a less delicate flavour than the lobster. Though its front legs make a very feeble show in comparison with the powerful chelæ of the lobster, when the mandibles are compared the advantage is greatly in favour of the *Palinurus*, or Crawfish as it is often called. Spence Bate has pointed out that in this genus and its immediate kindred there are button-shaped tubercles on either side of the trunk, which fit into cavities on the under surface of the carapace, and have a very great power of retention, this buttoning of the carapace being probably an important protection to the branchiæ that are placed beneath it. Its long stiff antennæ are said frequently to prevent it from entering the pots set for catching crabs and lobsters, and thus, while disappointing it in its search for food, indirectly help to save its life. As in *Palinurus* the ear-stones are introduced, and yet the animal has no claws with which to pick up grains of sand and place them in the auditory cavity at the base of the first antennæ, it might well be wondered how the otoliths reach their destination; but Hensen explains that the crustacean has only to burrow with its head in the sand, and the required particles will easily find their way into the ear-chamber.

[*Palinosytus*], Spence Bate, 1888, has the rostrum anteriorly produced so as to reach beyond the ocular segment, and by its connection with the segment belonging to the second antennæ forms a channel for the protection of the ocular segment. The first antennæ have two short flagella, and their segment is not produced beyond the extremity of the rostrum. This genus belongs at present only to the southern hemisphere. A specimen of *Palinosytus Lalandii* (Lamarck), ten inches long, was taken by the *Challenger* near Tristan da Cunha. Also a small specimen, about an inch long, was taken near the Cape of Good Hope, and this in all but sexual character already appeared to have the perfect adult form. *Palinosytus Hügelii* (Heller) is the common Crawfish of Sydney, in Australia, and if, as Haswell supposes, it be the same as the New Zealand *Palinurus tumidus*, Kirk, it must be credited with attaining

the great size of two feet in length, with a carapace more than twenty-one inches in circumference. Already in 1883, Mr. T. Jeffrey Parker, F.R.S., had proposed a new subgenus *Jasus* for those species of *Palinurus* which have the rostral character assigned to *Palinosytus* and which have no stridulating organ. He therefore claims that the name *Jasus* should supersede *Palinosytus*.

Linupāris, White, 1847, has the rostrum dilated, bipartite, with the processes flat, and the anterior margin spinulose. To this genus belongs *Linuparis trigōnus* (de Haan).

Panulīrus, White, 1847, contains the numerous Eastern and one or two Western species, in which there is no central rostriform tooth, which have the ocular segment exposed and membranous, the flagella of the first antennæ long and slender, and their segment produced considerably in advance of the frontal margin, that being generally armed with strong teeth. *Panulirus penicillatus* (Olivier) has already been mentioned as having exhibited the singular monstrosity of an eye-stalk developing a flagellum or lash-like termination. In this species Spence Bate enumerates twenty-six pairs of branchiæ, this number including six pairs of 'mastigobranchiæ,' which are in fact epipods, whether accompanied or not by podobranchiæ, which also arise from the first joint. With the help of Mr. R. I. Pocock, I have come to the conclusion that *Linuparis* and *Panulirus* were not named as generally supposed by Dr. J. E. Gray, but by Mr. Adam White, in 1847, the characters of the new genera being left to be inferred from those of the known species which were transferred to them, a slovenly method of definition which is much to be deprecated.

Palinurellus, von Martens, 1878, is distinguished from *Palinurus*, by the feeble antennæ, the nearly smooth carapace, and its rostriform front covering the base of the antennæ and eye-stalks. The type *Palinurellus gundlachi* is from Cuba. The genus *Synaxes*, which Spence Bate established in 1881, and retained in 1888, is described as having the rostrum produced beyond the segment of the first antennæ and united with that of the second antennæ

so as to make a perfect orbit and to cover the ocular segment. It is said to have the antennæ of *Palinurus*, the trunk-limbs like those of *Scyllarus*, the carapace like that of *Astacus*, and the pleopods like those of *Scyllarus*, so as to form a truly inosculant genus. The type species is *Synaxes hybridica*, Spence Bate, from the West Indies. Spence Bate himself observes that '*Palinurellus*, von Martens, according to that author differs from *Synaxes* in having the posterior pair of pereiopoda chelate in the female,' but does not explain how that can be any distinction, if, in *Synaxes*, 'the pereiopoda are like those of *Scyllarus*,' as he declares them to be, for in *Scyllarus* also the last pair are chelate in the female. The student must be prepared sometimes to find it as difficult to reconcile authors with themselves as with one another. Under the circumstances one may accept the decision of Dr. Boas, quoted with evident approval by von Martens, in 1882, that *Synaxes* is a synonym of *Palinurellus*.

The strange form known as *Phyllosoma* was at one time regarded as belonging to a distinct genus, but is now known to be larval, by such marks as the median eye, and the rudimentary character or unjointed condition of the various parts. A considerable number of specimens of *Phyllosoma* were obtained by the *Challenger*, of sizes varying from the seventeenth of an inch up to an inch and two-fifths, the latter being larger than some specimens of *Palinurus* that have attained the permanent form. In a general way the *Phyllosoma* forms may be assigned to different stages in the development of the Scyllaridæ and Palinuridæ, but to assign the successive stages to particular species does not seem always possible at present, and in especial there appears to be an awkward gap between the most advanced *Phyllosoma* and the earliest post-larval form. No such perplexity, however, affects the first larval form, or brephalos, when actually extracted from the ovum. A specimen of this kind is shown on Plate IX., in Spence Bate's figure of a juvenile *Palinurus vulgaris*.

CHAPTER XIV

TRIBE IV.—ASTACIDEA

THE first antennæ carry two multiarticulate flagella; the second are furnished with a scale. The trunk-legs have seven distinct joints. The first three pairs of trunk-legs, and sometimes the other two pairs also, are chelate. The first pair are the largest. The branchiæ are well developed. The first segment of the pleon has appendages, except in the Parastacidæ.

In this tribe the young are said to be hatched in the Megalopa form. It contains four families—the Eryontidæ, Nephropsidæ, Potamobiidæ, and Parastacidæ.

Family 1.—*Eryontidæ.*

The carapace is dorsally depressed, with little or no rostrum. The eyes are wanting or abnormal. The second antennæ have a long multiarticulate flagellum. The third maxillipeds are pediform. The pleopods, except the first pair, have a process attached to the inner branch (the *stylamblys* of Spence Bate's terminology). The uropods have no transverse suture. The telson is tapering.

To this family are assigned seven genera, but one of these, *Eryon*, Desmarest, 1820, which gives its name to the family, is a fossil genus from the Lias of England and the lithographic limestone of Bavaria. It is only in recent years that the depths of the ocean have yielded forms which appear to be properly classified in close proximity to the ancient fossil species.

Polychēles, Heller, 1863, has the anterior angles of the

carapace projecting ; the eye-stalks obscure, 'immovably lodged in an orbit excavated in the dorso-frontal margin of the carapace, more or less covered by the antero-lateral margin of the carapace ;' the second antennæ terminating in a long and slender flagellum ; the first four pairs of trunk-legs chelate ; the fifth pair simple in the male, sometimes chelate in the female ; the pleon not longer than the carapace. The type-species, *Polycheles typhlops*, Heller, was first taken in the Mediterranean. Since then various species have been recorded from both the Atlantic and the Pacific, and from depths varying from 220 to 1,070 fathoms. Since in the female all the legs are usually chelate, the generic name, meaning 'with many chelæ,' is not inappropriate.

Pentachēles, Spence Bate, 1878, meaning 'the creature with five chelæ,' seems to differ from *Polycheles* only in the particular alluded to in the generic name, the male in this instance, as well as the female, having the fifth pair of legs chelate. The genus has a wide range in both the great oceans, and the species descend to great depths.

Spence Bate observes that *Pentacheles euthrix* (v. Willemoes Suhm) has a close general resemblance to his own *Polycheles baccata*.

Stereomastis, Spence Bate, 1888, is said to differ in nothing externally from *Pentacheles*, but to be established 'to receive those species in which the mastigobranchial lash does not exist.' It was probably foreseen that some apology would be expected for such a definition, and the remark is accordingly appended, that 'difference of internal structure as a specific character is of more value than any external distinction, which, though more convenient for classification, is of little importance if it does not represent structural variation.' Yet the example of the present genus gives but feeble support to this sententious aphorism, especially as in the two preceding genera the mastigobranchial lashes are for the most part of great tenuity, and in *Stereomastis Suhmi*, Spence Bate, the third maxillipeds have 'a rudimentary mastigobranchial plate,' though the trunk-limbs are without any. The meaning of the generic name would naturally imply the presence

of a solid lash, but it is explained to mean 'the absence of a lash.'

Willemoesia, Grote, 1873, was at first named *Deodamia* by Dr. v. Willemoes Suhm, but that name was preoccupied. Here the eye-stalks are rudimentary, not lodged in a notch in the dorsal surface of the carapace, but in the frontal space. The first antennæ have the first joint produced to a scale-like process, which is forced up into a crest-like ridge; the two flagella are very unequal. The trunk-limbs are all chelate in both sexes. The telson tapers to a joint. The type species, *Willemoesia leptodactyla* (v. Willemoes Suhm), occurs in the Mediterranean, Atlantic, and Pacific between the depths of 1,300 and 2,225 fathoms. This and the species of the kindred genera are almost always taken on an oceanic floor of globigerina ooze, and Mr. Spence Bate infers from this that the character of the food may have been one of the most permanent influences in their geographical distribution. The remark is capable of a very extended application.

Family 2.—*Nephropsidæ.*

The carapace is sub-cylindrical, with a pronounced rostrum. The second antennæ have a long multiarticulate flagellum. The segments of the pleon are dorsally imbricated. The outer branch of the uropods has a transverse suture. The 'mastigobranchiæ' or epipodal plates are large, having a well-developed podobranchial plume attached to all the trunk-legs except the last pair.

Six genera are assigned to this family. Spence Bate calls it the Homaridæ, from *Homarus*, the name which Milne-Edwards gave to the genus containing the common lobster, but since that genus was already named *Astacus* by Leach, *Homarus* must be discarded as a synonym. Since a freshwater genus in a different family has been misnamed *Astacus*, by which the application of Astacidæ as a family name has been confused, it seems better to give a new family name to the lobsters, and for this purpose Nephropsidæ readily suggests itself.

Nephrops, Leach, 1819, has the eyes wider than their foot-stalks and reniform or kidney-shaped in accordance with the meaning of the generic name. The scale of the second antennæ is large, reaching the end of the peduncle. The first pair of trunk-legs are long, slender, and prismatic in shape, not very unequal. The type-species, *Nephrops norwegicus* (Linn.), is distributed generally through the seas of Europe, belonging not only to Norway, but also to Great Britain and the Mediterranean. It is a beautiful species both in form and colouring. According to Spence Bate, the branchial arrangement is identical with that of the common lobster, but Huxley draws a slight distinction, saying that 'the branchial plume of the podobranchiæ of the second maxillipeds is small or absent, so that the total number of functional branchiæ is reduced to nineteen on each side' in *Nephrops*, as compared with twenty in the lobster.

Sars has figured and described the 'second larval stage' (see Plate IX.),[1] the 'last larval stage,' and the 'first post-larval stage' of this species. The larval pleon is highly remarkable, not so much on account of the great dorsal spines that arise from the fourth, fifth, and sixth segments, as of the telson, which spreads itself out into two ciliated and spinulose spine-like branches, which together make its arch equal in breadth to the length of the animal.

A second species, *Nephrops Thomsoni*, Spence Bate, has been taken between Australia and New Zealand, and in the Philippines.

Eunephrops, S. I. Smith, 1885, is very near to *Nephrops*, except that, like the American lobster, it has a well-developed podobranchia to the second maxillipeds, and the scale of the second antennæ is very small. The type species, *Eunephrops Bairdii*, was taken in the Caribbean Sea.

Astăcus, Leach, 1814, has the eyes not wider than the foot-stalks and subglobose. The scale of the second antennæ is spine-like, not reaching the end of the peduncle.

[1] The form *norvegicus*, accidentally used on the Plate, is not the original spelling, but a later refinement.

The first pair of trunk-legs are large, robust, markedly unequal. The type-species is *Astacus gammărus* (Linn.), which Milne-Edwards and Bell speak of as *Homarus vulgaris*. Occasionally this is corrected by authors into *Homarus gammarus*. Spence Bate admits that Leach has undoubted priority, but regrets that to acknowledge his claim would only have the result of creating great confusion, which Leach himself would have deprecated, and that it would introduce terms not likely to be generally accepted. The sentimental consideration that Dr. Leach would deprecate a particular result may be dismissed, since in natural history the author of a name once published has no more control over it than any other person. In the due recognition of priority there is probably a better chance than any other principle affords of eventually clearing away confusion. No doubt, to our eyes. the age of Leach, as far as Crustacea are concerned, seems a kind of primitive antiquity, but in the perspective of another century or two the writers of to-day will seem to stand close by his side or very little in front, and if our nomenclature is carried out without principle, we must expect to be treated like the pre-Linnæan zoologists, and have our nomenclature put altogether out of court. It may be mentioned that Adam White, a considerable authority in his time, uses the name *Astacus gammarus* for the lobster, in his 'Popular History of British Crustacea,' published in 1857, thus showing that he was not to be daunted or led astray by the authority either of Milne-Edwards or of Bell. Leach remarks that 'Aristotle has very distinctly described this species under the name *αστακος*.' He is referring no doubt to the very interesting but rather perplexing second chapter of the fourth book of Aristotle's 'History of Animals.'

Astacus americanus (Milne-Edwards) closely resembles the European species, but has two spines on the under surface of the rostrum, which are wanting in its congener. It is, like the other, a large and extremely prolific species, much sought after for food. It is reckoned that a million a year are consumed in Boston alone. Professor S. I.

Smith has studied its development, and carefully described the embryo as it appears some time before hatching, also the first, second, and third larval stages, and the first post-larval stage. In this genus it appears that the Zoea stage

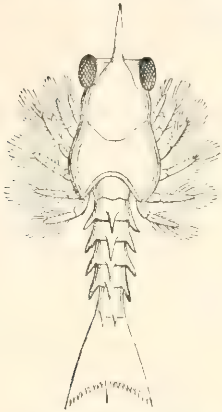


FIG. 17.—*Astacus Americanus* (Milne-Edwards), early larval form, dorsal view [S. I. Smith].

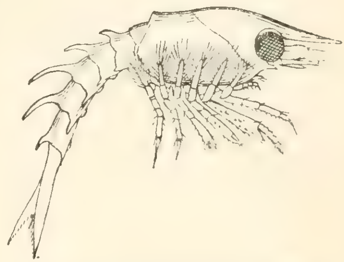


FIG. 18.—*Astacus Americanus* (Milne-Edwards), early larval form, lateral view [S. I. Smith].

is omitted, as far as the free existence of the animal is concerned, and that the young one is hatched in the Mysis

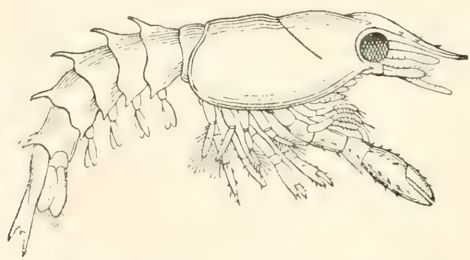


FIG. 19.—*Astacus Americanus* (Milne-Edwards), third stage [S. I. Smith].

form. Professor Smith did not accurately ascertain the age of the youngest larvæ he described, but supposed them to be at most a few days old and not to have moulted more

than once. In this stage they are free-swimming Schizopods about a third of an inch long, without appendages to the pleon, but with six pairs of pediform appendages under the carapace, each with an exopod developed into a powerful swimming organ. 'The eyes are bright blue; the anterior portion and the lower margin of the carapace and the bases of the legs are speckled with orange; the lower margin, the whole of the penultimate, and the basal portion of the ultimate segment of the abdomen [pleon], are brilliant reddish orange.' In the second stage appendages to the pleon have appeared on the segments from the second to the fifth, these same segments carrying dorsal spines as in the preceding and following stages, but with successive reductions in their size. In the third stage the appendages of the sixth segment of the pleon are well developed, although quite different from those in the adult. Considering that the Norway Lobster and the Common Lobster when adult are so nearly allied that they might almost be included in a single genus, the difference between the larval forms of the two is at first sight rather startling, but when more narrowly examined it will be seen that the structure in both is essentially the same, only that the telson of the larval *Nephrops* has been transversely outdrawn to a portentous extent. The larval *Porcellana* has been already mentioned as developing a monstrous spine in the longitudinal direction; the larvæ of the Cirripede, *Lepas fascicularis*, bristle with spines, and it is likely that many of the infant Crustacea may find in these processes an efficient protection to their minute and delicate frames against foes not much bigger than themselves. That they have such enemies it is easy to guess, and Professor Smith says of his young lobsters of the first stage, 'They appeared, while thus in confinement, to feed principally upon very minute animals of different kinds, but were several times seen to devour small zoëæ, and occasionally when much crowded, so that some of them became exhausted, they fed upon each other, the stronger ones eating the weaker.' We cannot afford to find fault with their juvenile morals, since similar prac-

tices have been followed, in some stages of society, by human beings themselves.

Phobĕrus, A. Milne-Edwards, 1881, has the eyes close together, small, and implanted on short rudimentary eye-stalks. The scale of the second antennæ is large. The first pair of trunk-legs are long, slender, and cylindrical; the second and third more slender and not quite so long; the fifth slightly subchelate. In *Phoberus tenuimănus*, Spence Bate, from New Guinea, the entire surface of the animal is spinous.

Nephropsis, Wood-Mason, 1873, has the eye-stalks small, the second antennæ without a scale, the first pair of trunk-legs large, the second slender, the third slender and with the chelæ minute, the last two pairs slender and simple. All the recorded specimens have been taken at great depths, from two or three hundred down to eight hundred fathoms. The type-species, *Nephropsis Stewarti*, Wood-Mason, from the Andamans, was supposed to be blind, but, according to Spence Bate, 'it appears both from Wood-Mason's own figures and from an examination of the *Challenger* specimens, that this genus cannot be described as being without organs of vision.' *Nephropsis atlantica*, Norman, from the Färö Channel, has small and immature eyes.

Eutrichochēles, Wood-Mason, 1876, was instituted to receive the *Cancer modestus* of Herbst from India, which, according to Wood-Mason, is 'especially interesting as being the nearest known blood-relation of the remarkable blind crayfish,' *Nephropsis Stewarti*.

Family 3.—*Potamobiidæ*.

The carapace is sub-cylindrical, with a pronounced rostrum. The fourth and fifth pairs of trunk-legs are not chelate. The outer branch of the uropods has a transverse suture. The first maxillipeds have an epipod devoid of branchial filaments; the second maxillipeds and the first three pairs of trunk-legs have the podobranchiæ always provided with a plaited lamina. None of the branchial fila-

ments and attendant setæ terminate in hooks. The first segment of the pleon has appendages in the male and usually also in the female, those of the four following segments being relatively small; in the male those of the first segment are stiliform, and those of the second segment are always peculiarly modified. The telson is frequently divided by a transverse incomplete hinge.

To this family three genera are assigned, which belong to the fresh waters of the northern hemisphere only.

Potamobia, Leach, 1819, meaning 'the creature that lives in a river,' is the genus that has so commonly of late years been called *Astacus*. The name is often also quite needlessly altered into *Potamobius*, and that by writers who use the name *Gebia* unchanged, properly ignoring Risso's pseudo-correction of it into *Gebios*. In *Potamobia* the last segment of the trunk carries a pleurobranchia and the two or the three preceding segments have rudiments of the pleurobranchiæ. According to Mr. Walter Faxon, whose authority on this subject is not likely to be disputed, the English species should be called *pallipes* (Lereboullet), the *Potamobia torrentium* (Schrank), and the *Potamobia fluviatilis* (Auctorum) being distinct. It will be remembered that it was on this genus that the celebrated Réaumur conducted his investigations into what was at the time something of a mystery, namely the exuviation or shedding of the coat of the crustacean. Here too Rathke found materials for studying the development of the embryo, unfortunately for the commencement of such a study lighting upon an exceptional group, in which the young enters into liberty in a form not very remote from that of its parents.

Cambărus, Erichson, 1846, has the pleurobranchiæ entirely suppressed, so far as is known, and the podobranchia of the fourth pair of trunk-legs has no lamina. The third pair of trunk-legs, and sometimes also the second or the fourth pair, have in the male the third joint provided with a conical, recurved, hook-like process, and in the female the hinder edge of the penultimate sternum of the trunk is elevated into a transverse prominence, on the

posterior face of which there is a pit or depression, an arrangement designated by Dr. Hagen as the *annulus ventralis.* Mr. Faxon enumerates no less than fifty-five species, twenty-one of them being described by him as new in 1884. *Cambarus Diogenes*, Girard, which is widely distributed in the United States, constructs curious 'chimneys' at the mouth of its burrows, and *Cambarus dubius*, Faxon, it is said, 'makes mud chimneys like *C. Diogenes*, which it seems to represent in the mountain regions, *C. Diogenes* belonging to the low lands.' *Cambarus argillicŏla*, Faxon, is closely related to the two preceding species. The types of it were dug out of burrows in solid blue clay in Detroit, Michigan. 'The burrows were three to five feet deep. At the bottom of each burrow was a pocket in a layer of loose gravel and clay, holding water. Just above the water-line an enlargement in the burrow formed a shelf on which the animal rested.' It is a pleasing picture of retirement, safety, and comfort, if one can accommodate one's mind to the feelings and requirements of a crayfish. *Cambarus pellucidus* (Tellkampf) is the blind species of Mammoth Cave, Kentucky, in which it is noticed as a singular circumstance that *Cambarus Bartonii* (Fabricius) occurs with well-developed eyes.

Cambaroides, Faxon, 1884, is only introduced by its author as a sub-genus of *Potamobia*, but it may as well follow its destiny at once and become a genus. Huxley in 'The Crayfish' mentions *Astacus dauricus*, Pallas, and *Astacus Schrenkii*, Kessler, as restricted to the basin of the Amur, which sheds its water into the Pacific over against Japan. He points out that the branchial system of the Amurland *Astaci* is apparently the same as that of the rest of the genus, but that the second and third trunk-legs in the male have a hook-like process on the third joint, and that the females have the transverse prominence already noticed in *Cambarus*. It is on this combination of characters from *Cambarus* and *Potamobia* that Faxon has founded his *Cambaroides*, to include the two species just mentioned and the *Astacus japonicus* of de Haan. In this species he suspects the existence of two forms of the male, a pecu-

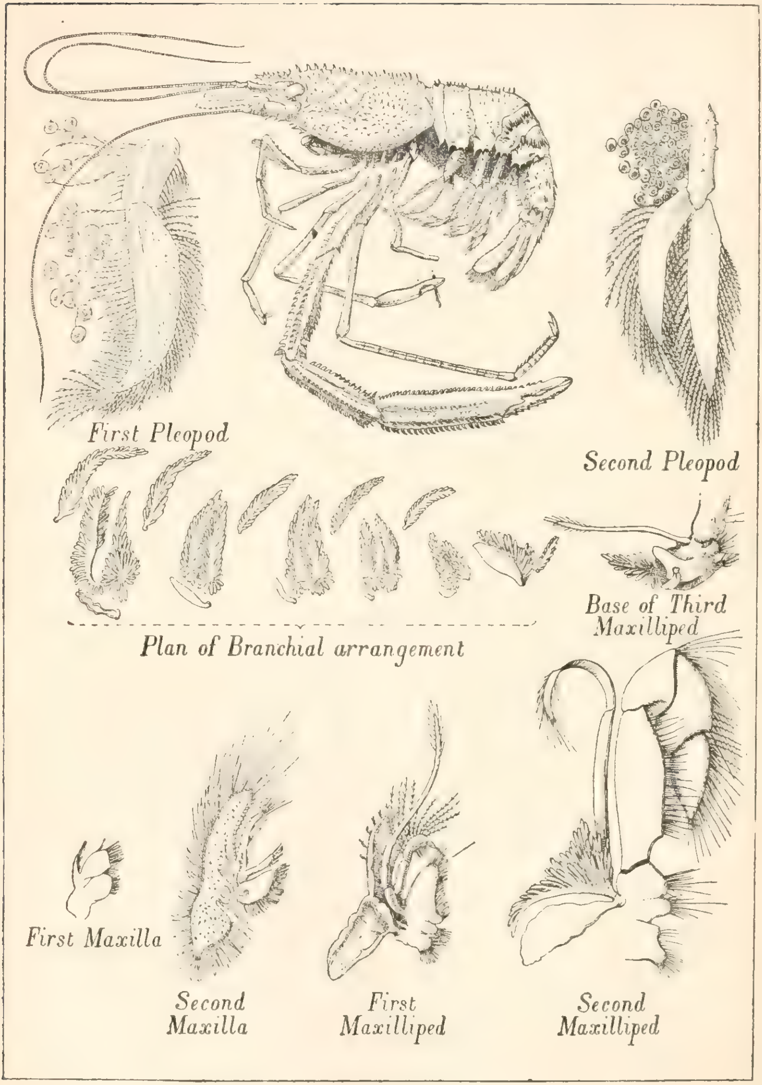
liarity that has long been known in the genus *Cambarus*. It was at one time supposed that one of the forms, not much differentiated from the female, might be sterile, and that the more highly developed and specialised form was the fertile male. But Mr. Faxon, having kept some specimens of the latter form under observation, found that after pairing at the next exuviation they assumed the less differentiated form, and his inference has been generally accepted that the two forms alternate in the same individual during a certain part of its life. As it is not probable that the Potamobiidæ have a monopoly of this curious changefulness, the chance of its occurrence is one more pitfall to be guarded against in the institution of new species.

Family 4.—*Parastacidæ.*

These agree very closely with the preceding family except in regard to the branchiæ, appendages of the pleon, and the telson. Here the first maxillipeds have the epipod almost always provided with a certain number of well-developed branchial filaments; the podobranchiæ of the following appendages are devoid of more than a rudiment of a lamina, while some of their filaments and attendant setæ terminate in hooks. The first segment of the pleon has no appendages in either sex, and the appendages of the four following segments are large. The telson is never divided by a transverse hinge.

To this family there are allotted six genera, all belonging to the Southern hemisphere, and living, like those of the preceding family, only in fresh or brackish waters. The facts of distribution in regard to the two families are remarkable. Several species of *Potamobia* are found in rivers of Europe and Asia, and five species of that genus exist in rivers of North America, west of the Rocky Mountains, whereas fifty-two species of *Cambarus* inhabit the rivers and lakes of North America east of that range. Of the Parastacidæ, *Astacoides*, Guérin, 1839, with its solitary species *madagascariensis*, is found only in Madagascar; *Parastacus*, Huxley, 1878, was established for

species that belong to Southern Brazil; *Paranephrops*, White, 1831, is found only in New Zealand and (possibly) Fiji, while even within the limits of New Zealand its two species, *planifrons* and *zealandicus*, are found by Mr. Chilton to have distinct and separate ranges; *Astacopsis*, Huxley, 1878, and *Engæus*, Erichson, 1846, belong to Australia and Tasmania, while *Chœraps*, Erichson, 1846, belongs to Australia alone. *Chœraps* was instituted only as a subgenus by Erichson, and by Mr. Haswell it is united with *Astacopsis*. Spence Bate, in remarking upon the peculiarities of distribution here set forth, speaks of 'the several genera being adapted each to its own locality, no two genera being known to exist in one habitat,' but to support this statement he assigns *Astacopsis* to Australia, *Engæus* to Tasmania, and *Chœraps* to Van Diemen's Land, intending perhaps a just reproach to those who altered the name of Van Diemen's Land into Tasmania. In fact the small burrowing *Engæus* may be peculiar to that island, and, if not, it is separated by rather subtle distinctions from *Astacopsis*, so that the three genera in question form a very united group, and it is singular that, while they agree together in their branchial arrangement, they differ in that respect from all the other genera in the two families under discussion. The unnamed 'Australian Crayfish' of Huxley, which sometimes reaches a length of twenty inches, is pronounced by Mr. Haswell to be *Astacopsis serratus* (Shaw). In *Paranephrops zealandicus*, Mr. Wood-Mason has observed that the young are specially fitted for attachment under the pleon of the mother. The specimens examined were under a third of an inch in length. The two hindmost pairs of legs have the sixth joint 'provided at its extremity with a strongly hooked, exceedingly acute, movable claw, and on the lower edge at the end with six or seven sharp spines, against which the claw folds, and thus forms a very efficient prehensile arrangement.'



Stenopus hispidus (Olivier)

CHAPTER XV

TRIBE V.—STENOPIDEA

THE carapace is produced to a laterally compressed rostrum. The first antennæ have two flagella, the second have a scale. The mandibles have a three-jointed palp. The exopod of the third maxillipeds is small, slender, and almost rudimentary. The first three pairs of trunk-legs are chelate, the third pair being the longest and largest. The branchiæ are filamentous; only the second maxillipeds have a podobranchial plume; the hindmost pleurobranchial plume is the largest. The first pair of pleopods is one-branched and foliaceous; the uropods and telson have no transverse suture.

Family Stenopidæ.

This being the only family has the characters of the tribe. It contains two genera long included among the Penæidæ, with which they agree in having the third pair of trunk-legs larger than the two preceding pairs, but separated from that group by the structure of the branchiæ. Of the third genus now transferred to this family, the branchiæ have not been described.

Stenŏpus, Latreille (in Desmarest), 1825, has a long, flat, obtusely pointed scale on the second antennæ, the third trunk-legs long and slender, the fourth and fifth pairs with the antepenultimate joint subdivided, the telson tapering. The genus ranges from the eastern to the western hemisphere and from the Arctic regions to the tropics. *Stenopus hispidus* (Olivier) is recorded from the Pacific, from Bermudas, and perhaps from Greenland. Spence Bate's figures of this species are reproduced on a re-

duced scale in the adjoining Plate. *Stenopus spinosus*, Risso, is from the Mediterranean.

Spongicŏla, de Haan, 1849, has but one species, *Spongicola venusta*, with an extensive range in the Pacific. The scale on the second antennæ is broad, not ending in a point, and fringed with long plumose hairs. The third pair of trunk-legs have the hand large and thick and the preceding joint short. In the two following pairs the antepenultimate joint is not subdivided, and the terminal joint is tridentate. The telson is ovate. The species is said to live in the beautiful *Euplectella* and other similar sponges

Aphăreus, Paulson, 1875, has the third trunk-legs long and slender; the fourth and fifth pairs with antepenultimate joint undivided and finger unidentate. The telson is acute. The third maxillipeds resemble antennæ, each of the two slender terminal joints being subdivided into four jointlets. The type species is *Aphareus inermis* from the Red Sea.

CHAPTER XVI

TRIBE VI.—PENÆIDEA

THE branchial structure typically consists of a series of plumes, that are attached by, or very near, their basal extremity to the animal, and from a long central stalk send off on each side a single row of branches that divide and subdivide in a variety of ways according to the genus or even the species. The appendages of the trunk are supplied with nerves from separate ganglionic centres, except the last pair, which is supplied not from its own segment but the preceding. The third pair of trunk-legs are chelate, the two following pairs never are. The extruded ova do not appear to be definitely attached to the appendages of the mother prior to hatching as in most other Macrura. The first larval form is supposed to be a Nauplius.

This tribe corresponds with what Spence Bate calls the Dendrobranchiata normalia, in allusion to the ramified, or tree-like structure of the branchiæ. He allots to it two families, the Penæidæ and Sergestidæ.

Family 1.—*Penæidæ.*

The carapace at the sides is deeply produced and carried further back than in the median dorsal line; its rostrum is laterally compressed, this part at least being carinated. Of the segments of the pleon the first three are usually not longitudinally carinate, but the three that follow are almost always much so. The sides of the first are produced so as to overlap the hind lateral margin of the carapace and the front lateral margin of the second

segment of the pleon. The telson is generally dorsally flattened or grooved. The eye-stalks are usually two-jointed. The first antennæ have two multiarticulate flagella, and the first joint of the peduncle flattened to receive the eye-stalk and laterally strengthened on the outer side by a spine-like process, on the inner by an unjointed appendage often fringed with hairs. The second antennæ have a broad, thin, foliaceous scale, and a long flagellum. The mandibular 'palp' is never more than two-jointed. The third maxillipeds are long and pediform. Both the second and third maxillipeds and the three or four following pairs of appendages carry 'mastigobranchiæ' or epipodal plates. The first three pairs of trunk-legs are chelate and similar, the second longer than the first, and the third than the second. The trunk-legs with occasional exception of the third pair have the antepenultimate joint unusually long in relation to the penultimate (in this respect agreeing with the Stenopidea and *Nematocarcinus*).

This family includes nearly a score of genera, only one of which frequents the shores of Great Britain. In his very detailed discussion of the family Mr. Spence Bate says that in the Penæidæ the anterior three segments of the pleon 'are never carinated, but those that are posterior to them are always extremely so.' Yet he subsequently mentions that *Penæus velutinus*, Dana, has the 'pleon carinated from the second somite to the posterior extremity of the sixth,' and he gives a similar account of three of his own species, besides mentioning two others in which the carina begins on the third segment. On the other hand in the description of *Penæus gracilis*, Dana, he says nothing of any carina on the pleon, but states that all the six segments are dorsally smooth. Similar remarks will apply to other genera. In *Sicyonia*, for example, he describes species which have the carina of the pleon extending from the first to the sixth segment, and in *Gennadas* species that have no carina on any segment of the pleon except the sixth.

Penæus, Fabricius, 1798, has a dorsally serrate rostrum,

two- or three-jointed eye-stalks, flagella of the first antennæ not longer than the carapace, a two-jointed mandibular 'palp,' the third maxillipeds long and pediform, the first three pairs of trunk-legs carrying exopods, the fourth and fifth pairs not longer than the preceding, the pleopods with two foliaceous branches in every pair except the first, which in the male has a large membranous appendage attached to the base. This appendage, called by Spence Bate the *petasma* or curtain, is rudimentary in the female. In this genus there are no podobranchiæ. The first species assigned to it by Fabricius was the large *Penæus monŏdon*, which occurs in the neighbourhood of Ceylon, Western Australia, and the Philippines, and is perhaps identical with the Japanese *Penæus semisulcatus* of de Haan. *Penæus caramote* (Risso) is found in the Mediterranean and Atlantic, and is sometimes taken in English waters.

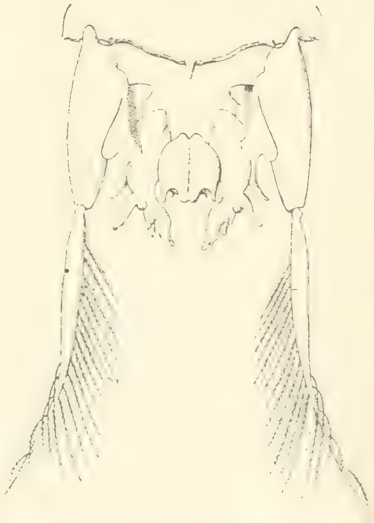


FIG. 20.—*Sergestes Atlanticus* (Milne-Edwards), first pleopods of the male, with petasmata united in the median line [Sp. Bate.].

Penæus canaliculatus, Olivier, appears to extend with little variation from Japan to Australia, and to differ only in small particulars from *Penæus caramote*. Thus, it has nine teeth instead of twelve on the dorsal crest, straight instead of wavy ridges on either side of the carina of the carapace, the spine on the outer margin of the first joint of the first antennæ not nearly instead of quite reaching the extremity of the eye, no tooth on the second joint of

the third trunk-legs; and the two teeth on each side of the telson in *caramote* are wanting in *canaliculatus*.

Penæus esculentus, Haswell, is said to be the common edible prawn of Sydney, Newcastle, and other places in Australia, and but few must be required to make a dish, if they often reach, as they do sometimes, the length of nine inches. It is perhaps not distinct from the type species of Fabricius.

In *Penæus* and some at least of the other genera in the family, there is on the ventral surface of the trunk a structure peculiar to the females, to which Spence Bate has given the name of *Thēlўcum* (see Plate XII.), 'which,' he says, 'so far as I am aware, has never been previously figured or described by any naturalist.' Yet he presently after refers to one description of it by de Haan, and might have mentioned that it is described by that author in no less than four species. Of the female of *Penæus canaliculatus*, de Haan says that 'the sternum is channelled between the three anterior legs, between the fourth having a narrow rounded horny lobe, and between the fifth a broader membranaceous orbiculate lobe, which in advance of the middle is cleft and embraces the median spine.' Referring to the same species and sex, Spence Bate says:—'On the ventral surface in both our specimens, between the posterior pair of pereiopoda, is a large thelycum, consisting of a dichotomous, calcareous capsule, which extends forwards as far as the base of the antepenultimate pair of pereiopoda, whence project two large, leaf-like, membranous appendages (Plate XXXII. fig. 4 ♀). They appear to be connected with the internal organs by means of foramina in the floor of the capsule, and have no connection with the fifth pair of pereiopoda.' Paulson also, in 1875, figures and describes these appendages in various species of *Penæus*. The organ appears to vary considerably in different species, but the question is complicated by the probability that it may undergo important changes of form at different stages of the animal's existence. Spence Bate's figures and descriptions will no doubt lead the way to the clearing up of this question.

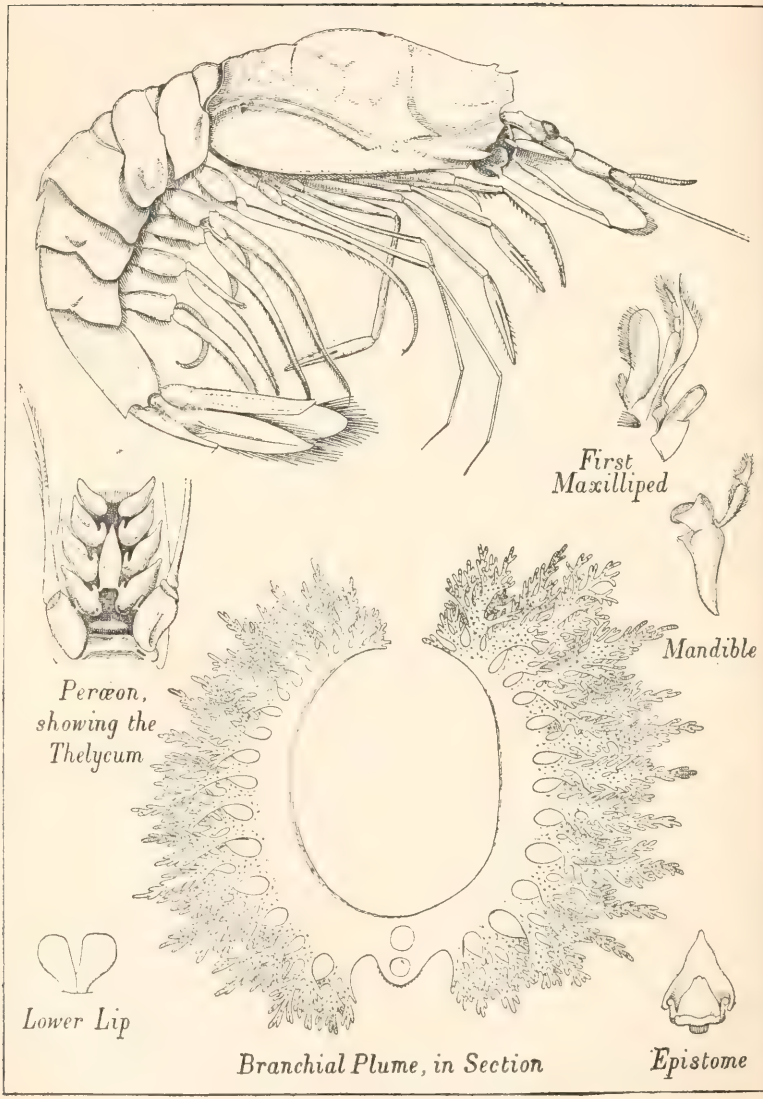
Another intricate matter is the development of *Penæus*. Fritz Müller in 1864 believed himself to have discovered the earliest stage. Of the brood of some prawns belonging to *Penæus* or some immediately kindred genus, he says, 'they quit the egg with unsegmented oval body, an unpaired frontal eye, and three pairs of swimming-feet, of which the first are simple, the other two two-branched, belonging, therefore, to the larval form so frequent among the lower Crustacea, to which O. F. Müller gave the name of *Nauplius*. No indication of a carapace, of the paired eyes, of mouth-organs near the mouth which is over-arched by a helmet-shaped hood!' Between this and the adult there are various *Zoea* and *Mysis* or Schizopod stages, not to mention the *Protozoea* of Claus interposed between the egg and the *Nauplius* form. Spence Bate alludes to the claim made by Professor Brooks in 1882 that, having captured and kept in confinement a specimen, he had witnessed every moult between the youngest Protozoea and the young *Penæus*, but against this is set the comment of Mr. Walter Faxon in 1883 that Professor Brooks' 'youngest Protozoea is an older stage than the youngest stage secured by Fritz Müller,' to which he adds that 'no observer has rediscovered Müller's Nauplius.' Hence Spence Bate himself says that 'two links of importance are yet wanting: the one is that which connects the earliest Protozoea form with Fritz Müller's Nauplius, and the other that which connects the Nauplius with *Penæus*; either of these being demonstrated will prove the connection, and establish the splendid hypothesis of Fritz Müller.'

Solenocĕra, Lucas, 1850, with its Mediterranean species *Solenocera Philippii*, Lucas, is by Victor Carus made a synonym of *Penæus siphonocĕras*, Philippi, but it differs from *Penæus* in having the flagella of the first antennæ longer than the carapace, and should therefore be called *Solenocera siphonoceras* (Philippi), the earlier name *Penæus membranaceus*, Milne-Edwards, having been already used by Risso for a different species. The flagella in question are rather remarkable, since the primary is very slender,

whereas the secondary is dilated and longitudinally hollowed so that its companion can be sheltered within it when not in use, but at other times the two pairs of flagella together form the efferent branchial tube, which is continued backwards by the peduncles of the first and the scales of the second antennæ, these making a broad channel between the bases of the peduncles of the second antennæ, where it is closed in below by the mandibular 'palp,' and diverges on each side of the upper lip into the passages from the branchial chambers. The generic and specific names alike signify 'a creature with channel- or pipe-forming antennæ.'

Pleotĭcus, Spence Bate, 1888, also has the flagella of the first antennæ longer than the carapace, but without the grooved arrangement. Its second antennæ claim notice as having the flagellum 'three times the length of the animal, or more.'

Sicyonia, Milne-Edwards, 1830, has its species, two of which occur in the Mediterranean, distinguished for the rigidity of the integument. The flagella of the first antennæ are very short; there are no exopods to the trunk-legs as there are in *Penæus*, and the pleopods are all single-branched. From *Penæus* it differs in the structure and arrangement of the branchiæ, though agreeing with it apparently in the absence of podobranchiæ. In defining the genus Spence Bate says that the second maxillipeds carry 'a mastigobranchial plate without a podobranchia,' 'one arthrobranchial and one pleurobranchial plume.' On the next page, after giving a scheme of the branchiæ of *Sicyonia* which includes six pleurobranchiæ and no podobranchiæ, he states that it differs from *Penæus* 'in the absence of any traces of pleurobranchiæ, in the reduction of the arthrobranchial plumes, and in the presence of one podobranchial plume attached to the first pair of gnathopoda' [*i.e.* second maxillipeds]. Presently after, in the description of *Sicyonia carinata* (Olivier), he says of these same second maxillipeds that the first joint 'carries a long and slender mastigobranchia shaped like that in *Penæus*, and, as in that genus, there is no branchial plume attached to it.' Thus there both is and is not



Hepomadus glacialis, Sp. Bate

a podobranchia to the second maxillipeds, and there are no traces of pleurobranchiæ although pleurobranchiæ are developed on six pairs of appendages. These are riddles which those who have specimens to compare with the descriptions may be able to solve.

Aristeus, Duvernoy, 1841, is distinguished from *Penæus* chiefly by the circumstance that on the second and third maxillipeds and the first three trunk-legs it has the podobranchiæ which the other is without. *Aristeus antennatus* (Risso) occurs in the Mediterranean and Atlantic, and is described as having a smooth pleon.

Hepōmădus, Spence Bate, 1881, is distinguished from *Aristeus* by a hepatic tooth on the shoulder of the carapace. *Hepomadus glacialis*, of which Spence Bate's figures are given in the adjoining Plate on a reduced scale, was taken near Yokohama at the frigid depth of 1,875 fathoms.

Several new genera from Atlantic exploring expeditions have been described in recent years by Professor S. I. Smith, as *Hymenopenæus*, 1882, meaning the membranaceous Penæus, *Amalopenæus*, 1882, which, at least in the type species *Amalopenæus elegans*, has only the sixth segment of the pleon carinate. Some of the lately described genera have names alluding to the great depths from which they were obtained : *Benthesicȳmus*, Spence Bate, 1881, *Benthœcĕtes*, S. I. Smith, 1884, *Benthonectes*, S. I. Smith, 1885, all meaning those that dwell or swim in the abysses of the billowy ocean. *Benthesicymus* has a submembranous integument, exopods to the limbs as in *Penæus*, podobranchiæ as in *Aristeus*, and the last two pairs of trunk-legs longer than the preceding pairs. One of the species, *Benthesicymus pleocanthus*, Spence Bate, was trawled from a depth of 3,050 fathoms in the North Pacific, while other specimens were taken twenty degrees further south in the smaller depths of 450 and 1,050 fathoms. *Benthonectes* is specially characterised by the multiarticulate flagelliform dactyli, that is the subdivided terminal joints, of the last two pairs of trunk-legs. *Xiphopeneus*, S. I. Smith, 1885, and *Benthœcetes* have a corresponding peculiarity in the propodi or sixth joint of the same limbs. In some of the

species of the deep-sea genera, such as *Benthesicymus* and *Gennadas*, Spence Bate, the eye-stalk sends out a prominently pointed tubercle, with a small circular lens at its extremity, served by a distinct branch of the optic nerve, this single lens being very translucent and without trace of pigment. *Gennadas* received its name, meaning 'of a noble race,' because it 'approximates nearer than any other to the little crustacean named *Penæus* (*Kolga*) *speciosus* in Salter and Woodward's map of fossil Crustacea.'

Peteinūra, Spence Bate, 1888, meaning 'flying-tail,' is established for a single species *Peteinura gubernata* (see Plate IX.), founded on a single specimen an inch long, taken at the surface of the Atlantic at night time. There can be no doubt that the supposition is justified that the specimen is an immature form. There is a very long slender rostrum such as is common in larval forms, but the strangest peculiarity is at the other extremity of the animal. The sixth segment of the pleon, which is about as long as the four preceding segments together, carries a pair of uropods of which the inner branch is small and rudimentary, whereas the outer is nearly as large as the rest of the animal, a truly prodigious rudder! If ever the tail could wag the dog, one might expect a parallel to that phenomenon in this instance.

Cerataspis, Gray, 1828, of which *Cryptopus*, Latreille, 1829, is a synonym, has been lately shown to have 'almost all the characters of the typical Penæidæ.' Gray referred his *Cerataspis monstrosus* to the 'Fam. Nebaliadæ (*Les Schizopodes* Latr.),' but Giard and Bonnier say, 'the antennules, the antennæ are absolutely those of the Penæidæ; the second maxilla possesses the four characteristic plates; the endopod of the first maxilliped is five-jointed, the second maxilliped is geniculate, the third is transformed into a locomotive appendage; the thoracic legs are provided with long swimming branches (exopods); the first three pairs end in chelæ; the last two are simple, &c.' Referring also to P. J. van Beneden's discovery of the nauplian embryo, they remark that 'among the Schizopods the nauplian embryo has only as yet been observed

in the *Euphausiæ*, while on the contrary it is very frequent among the Penæidæ.'

Family 2.—Sergestidæ.

The branchial system is impoverished or lost, the epipodal plates and podobranchial plumes, when present, being restricted to rudimentary structures on the second maxillipeds. The first pair of trunk-legs, and sometimes the second, are simple, the chelæ of the third are minute, the fourth and fifth pairs are feeble, rudimentary, or absent.

The genera assigned to the family are *Sergestes*, Milne-Edwards, 1830; *Acetes*, Milne-Edwards, 1830; *Petalidium*, Sp. Bate, 1881; *Sciacāris*, Sp. Bate, 1881; and *Lucifer*, Vaughan Thompson, 1829, a pre-occupied name altered to *Leucifer* by Milne-Edwards in 1837. A very few remarks must suffice on the discrimination of these genera. In *Sergestes* the last two pairs of trunk-legs are rudimentary, in *Acetes* the last but one is reduced and the last is wanting, in *Leucifer* both pairs are absent. In *Sergestes* the arthrobranchiæ are wanting, in *Petalidium* they are found on the second and third maxillipeds and the first three pairs of trunk-legs. In *Sergestes*, Professor Smith remarks, the branchiæ are compound phyllobranchiæ, while those of *Penæus* in the preceding family are compound trichobranchiæ.

The larval forms of *Sergestes* have been partitioned into genera and species. The youngest form known is designated *Elaphocāris* by Dohrn (see Plate IX.); another, and presumably later form, is called *Platysăcus* by Bate; this is followed by *Acanthosōma*, Claus, and that by *Mastīgŏpus* of the same author. The species known as adults are very numerous, of very various sizes, from many differing localities, *Sergestes atlanticus*, Milne-Edwards, being found both in the Mediterranean and in the Atlantic from Greenland to the tropics. The account of the genus occupies eighty-eight quarto pages and seventeen plates of Spence Bate's 'Report on the *Challenger* Macrura.' It

was the subject of a monograph by Kröyer in 1856, and the interest of the subject seems still very far from being exhausted.

Sciacăris, 'the shadow shrimp,' is interesting as having a telson which ends in 'two lateral uniarticulate appendages,' but it is doubtfully founded on three specimens from the Pacific, none of which is adult, and none of which exceeds by more than a hair's breadth a sixth of an inch in length.

Acetes indicus was described by Milne-Edwards in 1830, the type-specimens having been taken at the mouth of the Ganges. According to Spence Bate, these are the only specimens known, so that some one must be responsible for a wrong date when he says that with them in the Paris Museum 'was a note stating that they were taken in 1852 from a large fish "21 feet in length and 25 broad" (*Dicerobates eroogoodoo*); its stomach was filled with myriads of these little crustaceans, which were carried away in bucketfuls by the fishermen, and thousands were left scattered about the shore.' As the crustacean is only an inch long, the above-mentioned fish, otherwise known as the Ox-ray, or Sea-devil, which may attain the weight of a ton, and has a mouth large enough to swallow a man, would no doubt find room for a shoal of these little shrimps. The Ox-ray occurs in the Mediterranean, and might well be the 'great fish' referred to in the book of Jonah.

Leucifer is without branchiæ; it has the two anterior pairs of trunk-legs without chelæ, and the chelæ of the third pair imperfect; the ova are carried beneath the trunk, but apparently without any special means of attachment. The genus is widely distributed over the tropical and sub-tropical waters of the Atlantic and Pacific, but is supposed to be limited to the two long known species, *Leucifer typus* (Vaughan Thompson) and *Leucifer Reynaudii*, Milne-Edwards. It has been made the subject of an elaborate study by Professor Brooks. After the *Nauplius* and *Zoea* stages, the young appear to go through transformations corresponding with those of *Sergestes*.

The ingenious comparison instituted by Darwin between the Macruran *Leucifer* and the Cirripede *Lepas* is well known, and, as the illustrative figures have often been reproduced, the long neck, the projecting eyes, and feeble limbs of *Leucifer* are comparatively familiar. The petasma, or curtain, at the first pleopods of the male, is in this genus a very conspicuous object.

Schizopoda.

Spence Bate regards the Schizopods as an aberrant group of his Macrura dendrobranchiata, and urges that, 'with the exception of the variable condition of the pereiopoda, the several genera do not possess a single character that is not held in common with some genus of the Macrura.' Without any wish to pronounce upon the validity of the arguments and facts which he adduces in support of his view, I must here simply follow the dictates of convenience, and leave the Schizopoda to be treated later on as a separate sub-order.

CHAPTER XVII

TRIBE VII.—CARIDEA

The respiratory system is phyllobranchiate, that is, the series of branchial plumes are 'developed in the form of broad foliaceous plates of extreme tenuity, attached to a central stalk.' The first two pairs of trunk-legs are frequently but not invariably, and the last three pairs are never, chelate. The ova when extruded are carried attached to the pleopods of the female.

This tribe contains four legions, the Crangoninea, Polycarpinea, Monocarpinea, and Haplopodinea. It corresponds with the group of normal phyllobranchiate Macrura of Spence Bate, to which he assigns four tribes of the same extent as the four legions just named.

Something like the Grecian bend, at one time fashionable in feminine gait and costume, is often conspicuous in the species of this tribe. To this may be attributed the title *eukyphota*, meaning the well-bent animals, applied by Dr. Boas to a group in which he includes the genera *Palæmon*, *Palæmonetes*, *Pontonia*, *Hippolyte*, *Pandalus*, *Alpheus*, *Caridina*, *Crangon*, *Pasiphæa*, all of them members of the present tribe.

Legion 1.—*Crangoninea.*

The first pair of trunk-legs is subchelate, the second feeble or imperfect, with the fifth joint not subdivided.

Family—Crangonidæ.

This being the only family might be content with the characters of the legion, but others are added for convenience of comparison with those in families of the next

legion. The hind margin of the carapace is overlapped at the sides by the first segment of the pleon; in the rear the pleon is laterally compressed. The eye-stalks are short and one-jointed. The first antennæ have two flagella, the second have a large scale, and all the joints of the peduncle free. The mandibles are without a cutting edge, and have no 'palp.' The second maxillipeds end in a rudimentary sixth joint, and the third pair have neither the sixth nor the seventh joint. The second and third pairs of trunk-legs are slender, the others robust. The pleopods are two-branched, the swimming-fan well developed.

This family at present contains some eight or nine genera, in most of which the second pair of trunk-legs are more or less chelate, but in *Sabinea*, Owen, 1835, they are simple, and in *Paracrangon*, Dana, 1852, this pair of legs is completely obsolete.

Crangon, Fabricius, 1798, the parent genus, has the carapace and minute rostrum dorsally flattened. The type species, *Crangon vulgaris* (Linn.), is abundant on the sandy shores of Great Britain. So also in the Mediterranean and on the shores of Europe at large, in the seas of Japan, on the East and West Coasts of North America, in short over all the northern hemisphere this species seems to make itself at home wherever there is a plentiful supply of fine sand. Apparently in the zoological ideas of many persons it is not only the typical shrimp, the shrimp *par excellence*, but the only shrimp. At least the information that there is more than one species of shrimp, in fact that there are several or indeed a rather large number of species, often excites surprise not always wholly unmingled with scepticism. Familiar also as the eatable shrimp is to every one, vague notions sometimes prevail as to its anatomical structure. A very intelligent student, on being told that the eyes were stalked, candidly confessed to having always thought that this appearance was due to their having been forced out of the head by boiling. The colour of the species is said to vary much with the ground it inhabits, but specimens that live in shallow waters are of a speckled grey which harmonises well with the wet

sand, in which they may often be observed to bury themselves with great facility after making an abrupt leap to escape the hand stretched out to capture them. They need, it is said, all their powers of concealment, being eagerly hunted and captured by nearly all the larger fishes which frequent the same waters, and, according to Verrill and Smith, on the American coast this species constitutes the principal food of the weak-fish, king-fish, white perch, blue-fish, flounders, striped bass, and others. It may be readily surmised that many of the flat-fishes, lying as they do on the floor of the sea, must have a great advantage in the sport of shrimping. A second species, *Crangon Allmanni*, Kinahan, found in Great Britain and Norway, is distinguishable by the two parallel keels of the sixth segment of the pleon, the groove between the two keels being an easily discerned feature. This is found in deep water. Kinahan in 1864 instituted for it a new genus *Steiracrangon*, which may be allowed to lapse. It is not mentioned in 'Bell's History of the British Stalk-eyed Crustacea,' not being known when that was published. Bell there records six species of *Crangon*, but, except in the case of *Crangon vulgaris*, the names he gives them are not universally accepted. For *Crangon fasciatus*, the name *Egeon fasciatus*, Risso, is sometimes preferred, Bell's own species *Crangon sculptus* being transferred to the same genus, because the carapace in these species is not dorsally depressed.

Crangon spinosus, Leach, 1815, according to Sars, properly belongs to the genus *Pontophĭlus*, Leach, 1817, of which it is the type. *Crangon trispinosus* (Hailstone) and *Crangon bispinosus* (Westwood) have been assigned (but the first with very doubtful correctness) to *Cheraphilus*, Kinahan, 1864, in which, as in *Pontophilus*, the second trunk-legs are much shorter than the third, instead of being equal to them in length as in *Crangon*. *Crangon bispinosus* is now identified with *Crangon nanus* of Kröyer, and may therefore be called *Cheraphilus nanus*. Nevertheless all the seven species above mentioned are by some writers still retained in the genus *Crangon*, together with two others also found in British as well as Norwegian

waters, the *Cheraphilus echinulentus* of Michael Sars, and *Cheraphilus neglectus*, G. O. Sars. The last-named author, however, has quite recently been able to make a very unexpected contribution to the settlement of the question, for, in examining the development of different members of the family, he has found that the various genera and species are often more strongly distinguished in the larval forms than in the adults, so that the hesitation felt about separating, for example, the species *Crangon vulgaris* and *Crangon Allmanni*, or the genera *Cheraphilus* and *Pontophilus*, can no longer reasonably be persisted in. *Cheraphilus*, it may be mentioned, agrees with *Crangon* in having five pairs of branchiæ attached respectively to the five pairs of trunk-legs, but *Pontophilus*, while agreeing with *Cheraphilus* in the shortness of the second legs, differs both from it and *Crangon* in having six pairs of well-developed branchiæ, besides a rudimentary pair on the second maxillipeds. Since the species *Egeon fasciatus*, Risso, has been provided by nature with a remarkable brown band across the fourth segment of the pleon and similar colouring on the tail-fan, as if to separate it unmistakably from all other species, and to enable the collector to identify it without further trouble, it may be well to notice that *Cheraphilus neglectus* also has a deep brown band across the fourth segment of the pleon and a narrower one across the tail-fan, so that after all the collector has need to be cautious.

The arctic *Sabinea septemcarinata* (Sabine) agrees with *Pontophilus* in the branchial formula. In describing it in 1821 Sabine calls attention to the fact that the second legs are 'unarmed,' that is, simple or not chelate, and, while recognising that this is an 'essential point' of distinction from the known species of *Crangon* and *Pontophilus*, he enters one of the common but always useless protests against the multiplication of genera. If he spoke thus in 1821, what would he have thought in 1891? Kröyer, who redescribed the species in 1842, after stating that it is very abundant at Spitzbergen, adds that he had found the stomach of the seal *Phoca barbata* quite filled with it.

It has been ascertained by Sars that a curious form which Kröyer described under the name of *Myto Gaimardii* is one of the larval stages of this seven-keeled *Sabinea*. In 1842 Kröyer also instituted the new genus *Argis*, to receive the Arctic *Crangon lar*, described by Owen in the 'Zoology of Captain Beechey's Voyage.' Some years later Brandt established for the same species the genus *Nectocrangon*, meaning 'the swimming shrimp,' in allusion to the swimming properties of the very dilated fourth and fifth pairs of legs. But, however appropriate, the name must yield priority to *Argis*.

Sclerocrangon, Sars, 1882, has a hard and thickly incrusted integument, a rostrum expanded below into a hatchet shape, a very short finger to the second legs, and the pleopods with the inner branch much shorter than the outer. This genus has been established to receive the *Cancer Boreas*, described in 1774 by the arctic voyager, J. C. Phipps, afterwards Lord Mulgrave. To the same genus is referred another Arctic species, the *Crangon salebrosus* of Owen, and with less certainty the Mediterranean *Crangon cataphractus*, Olivi.

Pontocăris, Spence Bate, 1888, with two species from the south of New Guinea, has a multicarinate carapace, short chelate second legs, and a branchial formula nearly the same as that of *Pontophilus*.

Rhynchocinētes, Milne-Edwards, 1837, derives its name from the circumstance that the very large lamellate rostrum is articulated with the carapace. The species *Rhynchocinetes typus*, Milne-Edwards, is found on the coasts of New Zealand, Australia, and Chili.

Legion 2.—Polycarpinea.

The name signifies literally 'many-wristed,' and the distinguishing character of the legion is that in the slender second pair of trunk-legs the carpus, wrist, or fifth joint is multiarticulate, that is, subdivided into a greater or less number of minor joints. It includes four families, Nikidæ, Alpheidæ, Hippolytidæ, and Pandalidæ.

Family 1.—*Nikidæ.*

The rostrum is horizontal with the dorsal surface of the carapace; the mandibles are without a cutting edge, and are without 'palp;' the first pair of trunk-legs are simple or chelate, and stronger than the second, but not so long; the second are minutely chelate.

To this family Spence Bate apparently refers three genera distinguished as follows:—

Nika, Risso, 1816, with one of the trunk-legs of the first pair chelate, and the other simple.

Glyphocrangon, A. Milne-Edwards, 1881, with both of the trunk-legs of the first pair simple.

Lysmata, Risso, 1826, with both of the trunk-legs of the first pair chelate.

There are various other marks of distinction, such as the flagella of the first antennæ, of which in *Nika* one is long, the other short, while both are short in *Glyphocrangon*, and both long in *Lysmata*, this latter genus carrying also a third lash which is short. In *Nika*, the second pair of trunk-legs are, like the first, not strictly a pair, since they differ greatly in length. *Nika edūlis*, Risso, is found in British waters. On the shores of the Mediterranean it is used for food, as the specific name implies, and the same is said of *Lysmata seticaudata*, Risso, a coral-red species, longitudinally striped with whitish lines. Bell describes a second British species of *Nika*, as *Nika Couchii*, in which the telson is not channelled, and Spence Bate speaks vaguely of a British specimen of his *Nika processa* taken by the *Challenger* at Amboina, but apparently without any intention of separating the British specimens from *Nika edulis*, and in his edition of Couch's 'Cornish Crustacea,' he expressly says that *Nika Couchii* of Bell is nothing more than a variety of *N. edulis*. Of *Glyphocrangon* many species have been described from north and south and east and west, some of the forms descending to great depths; but Spence Bate, who names no less than six of the species, says that 'the various forms of this genus can scarcely be considered as being more than

varieties of one great type.' In *Glyphocrangon aculeatus*, A. Milne-Edwards, the carapace is ornamented with eight carinæ, but in *Glyphocrangon granulosus*, Spence Bate, there are five on each side of the median line, besides a small central one on the rostrum. The telson in this genus is described as a long bayonet-shaped organ, which the animal during life has the power of locking in a fixed position, so as to render it a very powerful weapon of offence, and of again unlocking at its own will. When fixed for striking it is supported in position by having a strong cusp or tubercle on its dorsal surface brought into contact with a curved process of the preceding segment. *Glyphocrangon rimapes*, Spence Bate, was trawled in the South Atlantic from a depth of 1,715 fathoms, and it is noted as an instructive coincidence that in *Willemoesia leptodactyla*, obtained in the same haul, the organs of vision are reduced to a rudimentary condition, while in *Glyphocrangon* they are unusually large.

Nikoides, Paulson, 1875, is distinguished from *Nika* by having an exopod on the first pair of feet, and by subdivision of the fourth joint as well as of the fifth in the second pair. The type *Nikoides Danæ* is from the Red Sea.

Family 2.—Alpheidæ.

The rostrum is minute or of moderate size; the eye-stalks are short, and more or less covered by the projection of the frontal margin of the carapace; the mandibles have a cutting edge distinct from the molar process, and a one- or two-jointed 'palp;' the first pair of trunk-legs are robustly chelate, sometimes unsymmetrical, the second pair are long and slender, minutely chelate.

Spence Bate makes a two-jointed mandibular 'palp' a character of the family, but in describing his own genus *Paralpheus*, he says that it is uniarticulate, and in *Alpheus*, Fabricius, 'three-jointed,' the latter being probably a slip of the pen for two-jointed. Ten or more genera have been assigned to the family, two of which occur on the coasts of Great Britain.

Alpheus, Fabricius, 1778, has a short pointed rostrum,

the eye-stalks covered by the translucent anterior region of the carapace. The inner flagellum of the first antennæ has a tendency to bifurcate. The second antennæ have a long flagellum and a strong scale with a subapical tooth. The mandibular 'palp' is short and two-jointed. The third maxillipeds are five-jointed. Spence Bate says that the second also are five-jointed. In de Haan's figure they are six-jointed. In Spence Bate's own figure they are obscurely, in Savigny's figure they are clearly, seven-jointed. The trunk-legs of the first pair are unequal and unsymmetrical, the hand or sixth joint on the right side being generally longer than that on the left, and more or less abnormal in form, especially in the male. The outer branch of the uropods has a transverse suture. The telson is broad and terminally rounded. The genus has a vast range between the north and south temperate zones, but seemingly confined to moderate depths. 'A specimen of *Alpheus minus* has been recorded from an inland fresh-water pond in south-west Colorado.' Spence Bate enumerates seventy species; but with a warning that many of them are separated by trifling distinctions, and are probably at most not more than varieties. Referring to de Haan's account of *Alpheus avarus*, Fabricius, he says that it appears to have no strongly marked feature separating it from *Alpheus Edwardsii* (Audouin). Mr. E. J. Miers in his account of the latter species identifies with it not only de Haan's *Alpheus avarus*, but some fourteen other names. On the other hand he considers that the *avarus* of Fabricius is distinct from that of de Haan. *Alpheus comatularum*, Haswell, is an eastern species said to be invariably found clinging to the arms of a Comatulid star-fish, to which its variously distributed stripes and markings of purple and white and light and dark brown give it a general resemblance that is presumably protective.

Alpheus ruber, Milne-Edwards, is occasionally taken on the English coast as well as in the Mediterranean. *Alpheus megachēles*, Hailstone, is identified by Canon Norman with the *Alpheus affinis*, Guise, from the Channel Islands, which is described as of a 'deep scarlet colour,

except on the chelæ, which are mottled with yellow.' Krauss at Natal found *Alpheus Edwardsii* in monstrous numbers in the mud of the bay, in which, he says, they dig deep perpendicular holes. When the tide is out they sit at the mouths of their burrows, but at any one's approach, rapidly ensconce themselves, making as they do so a snapping noise. How the sound was produced Krauss was unable with all his pains to discover.

Athănas, Leach, 1814, differs in several respects from the character of the family as given by Spence Bate in his report on the *Challenger* Macrura, since the rostrum is well developed instead of being reduced to a minimum, the eye-stalks are only partially instead of entirely covered by the carapace, and the first pair of trunk-legs, though unequal in size, are not unsymmetrical in shape. The first antennæ have three flagella, the second a long ovate scale with distal tooth.

Athanas nitescens, Leach, is British, and is found also in the Mediterranean. Spence Bate describes a new species, *Athanas veloculus*, from the Cape Verde Islands.

Parathanas, Spence Bate, 1888, is said to be closely allied to *Athanas*, but to have on the first antennæ only two flagella, one of which is very short. The type species is *Parathanas decorticus*, but to this is added *Parathanas immaturus* n. sp., founded on a specimen scarcely a fifth of an inch in length, from which 'unfortunately all the pereiopoda are broken off short.' It is spoken of as 'a damaged specimen of what appears to be another species,' and the admissions are made that 'there is little to determine the true character of the specimen,' and that 'the only distinguishable difference is that the rostrum is longer in proportion to the animal.' Since comparative measurements in immature animals have no specific value, one is tempted to transfer the ungallant observation about 'most women' to *Parathanas immaturus*, and say that 'some species have no character at all.'

Betæus, Dana, 1852, has no rostrum, and the 'hands' of the first legs more or less inverted, so that the finger or seventh joint is on the outer instead of the inner side. In

other respects it agrees with *Alpheus*, and the motive of its name seems to be that as Beta stands close to Alpha in the Greek alphabet, *Betæus* may be understood to stand close to *Alpheus* in generic character. *Betæus malleodigitus*, Spence Bate, from Fiji, has the finger of the first legs shaped like a mallet, in that respect resembling *Alpheus malleator*, Dana, and *Alpheus obesimănus*, Dana. *Betæus microstylus*, Spence Bate, is distinguished with some doubt from *Betæus æquimănus*, Dana.

Family 3.—Hippolytidæ.

The rostrum is of important size; the eyes are not covered by the carapace; the mandibles may have a cutting edge and 'palp,' or be without one or both. The first pair of trunk-legs have moderate-sized chelæ; the second pair are also chelate, with the wrist or fifth joint sometimes much and sometimes little subdivided.

A dozen or more genera are included in this family. It is impossible here to do more than give an indication of the complexity to which Spence Bate has afforded a clue so far as his own views of the family are involved, but there is little agreement as yet as to the precise classification of some of the genera concerned.

The *Challenger* collection gave Spence Bate occasion to deal with nine genera, seven of which were named or established by himself. With these may be arranged *Caridion*, a name substituted by Goës in 1863 for the preoccupied *Doryphorus* of Norman, and two genera that were instituted in 1869 by G. O. Sars, although in neither of them is the rostrum quite up to the importance demanded by the character of the family. It must suffice here to refer only to the mandibles and the second pair of trunk-legs, using the word 'wrist,' for brevity's sake, instead of saying in full the fifth joint of the second pair of trunk-legs.

Platybēma, Spence Bate, 1888. Mandibles without cutting edge or 'palp.' Wrist two-jointed.

Caridion, Goës, 1863. Mandible with cutting edge and three-jointed 'palp.' Wrist two-jointed.

Latreutes, Stimpson, 1860. Mandibles without cutting edge or 'palp.' Wrist three-jointed.

Hippolўte, Leach, 1813. Mandible with cutting edge, without 'palp.' Wrist three-jointed.

Cryptochēles, Sars, 1869. Mandible with cutting edge, without 'palp.' Wrist seven-jointed.

Bythocāris, Sars, 1869. Mandible with cutting edge, without 'palp.' Wrist nine-jointed.

Spirontocāris, Spence Bate, 1888. Mandible with rudimentary cutting edge, and 'palp.' Wrist seven-jointed.

Nauticāris, Spence Bate, 1888. Mandible without cutting edge, with three-jointed 'palp.' Wrist seven-jointed.

[*Hetairus*], Spence Bate, 1888. Mandible with cutting edge and two-jointed 'palp.' Wrist seven-jointed.

Merhippolўte, Spence Bate, 1888. Mandible with cutting edge and three-jointed 'palp.' Wrist many-jointed.

Chorismus, Spence Bate, 1888. Mandible with rudimentary cutting edge and three-jointed 'palp.' Wrist many-jointed.

Amphiplectus, Spence Bate, 1888. Mandible with cutting edge and two-jointed 'palp.' Wrist many-jointed.

Of these genera the first is not new but newly named, having been originally called *Cyclorhynchus* by de Haan, and then *Rhynchocyclus* by Stimpson, in allusion to the laterally compressed, deep, and terminally orbiculate rostrum. Unfortunately both names were preoccupied. The new name literally means a broad platform, but was evidently given under the impression that, as in English the word rostrum may stand either for a beak or a platform, so the Greek word for a platform might equally well stand for a beak, which is not exactly the case. The distinctions between this genus and *Latreutes* reach almost a vanishing point, when it is observed that both Stimpson and de Haan give to the type species *Platybema planirostris*

a three-jointed wrist, not a two-jointed one as in *Platybema rugosus*, Spence Bate. The last-named author appears only to have read de Haan's generic and not his specific description. One mark of distinction alone appears to stand, namely, that the second maxillipeds of *Platybema* are six-jointed, and those of *Latreutes* seven-jointed.

Caridion contains the British species *Caridion Gordoni* (Spence Bate).

Hetairus must, I think, become a synonym of *Spirontocaris*. In his synopsis ('Challenger Macrura,' p. 577) Bate says that *Hetairus* has no cutting edge to the mandibles, which is contrary to the fact and to his own statements on pp. 610 and 612. He says that its third maxillipeds differ from those of *Hippolyte* and *Spirontocaris* in having no exopod. Yet in *Hippolyte Gaimardii*, Milne-Edwards, which he makes the type-species of *Hetairus*, they undoubtedly have an exopod. Further he says that the first and second maxillæ of that species are 'unlike those of *Spirontocaris*.' This is clearly a slip of the pen. Yet it is a pity that reference should be made to a figure which is not given to illustrate an unlikeness which does not exist.

Hippolyte is a genus that has been involved in much confusion, and that has been made the recipient of many species. Bell, in 1853, was content to assign to it six British species, but Adam White, in 1857, augments the number to twelve. Some of these have since been transferred to the genus *Virbius*, Stimpson, 1860, but not correctly, for Spence Bate points out that *Hippolyte varians*, Leach, is the type-species of *Hippolyte*, and, as Stimpson has placed it in his genus, it shows that *Virbius* is a synonym of *Hippolyte*. The species is very common in tidal pools, and sometimes it has the red hue of the seaweed among which it is found, and at other times it is dark green or light green, but the name is appropriate to the fact not that the colour is different in different specimens, but that it varies in the same specimens, so that an animal which is red at one time will be green at another; or may possibly go through the whole series of

hues which Professor Kinahan mentions when he says, 'the specimens vary remarkably and beautifully in colour; pink, red, salmon, emerald-green, cobalt-blue, gray, chocolate-brown, opal white, are among the prevailing tints; the ova of a chocolate-brown.' *Hippolyte viridis* (Otto) is another species common to Great Britain and the Mediterranean, of which two species mentioned by Adam White, namely *Hippolyte Mitchelli*, Thompson, and *Hippolyte Whitei*, Thompson, are merely synonyms, while in the opinion of Czerniavsky, at least in 1869, *viridis* itself is a synonym of *Hippolyte Prideauxiana*, Leach, which is found on the coast of Devon. A third British species is *Hippolyte fascigera*, Gosse, which has the 'body studded with deciduous tufts of plumes,' and a fourth is the slender Mysis-like *Hippolyte producta*, Norman, 1861.

Having restored *Hippolyte* to the place occupied by *Virbius*, Spence Bate established the genus *Spirontocāris* to receive those species which could in consequence no longer stand under *Hippolyte*. Of this new genus he makes *Hippolyte spinus* (Sowerby) the type as *Spirontocaris spinus*, and considers *Hippolyte securifrons*, Norman, a synonym of it. The species extends its range from the north of Great Britain to Iceland and Greenland. A Norwegian species was briefly described in 1861 as *Hippolyte Liljeborgi*, by Danielssen, who says: 'The rostrum is very prominent, laterally compressed, and ending in a strongly upward bent spine; the upper margin furnished with ten nearly equally large, strong spines; yet the two first are a little smaller; the innermost margin is strongly convex and in front furnished with three spines.' As this is acknowledged to be identical with Norman's *securifrons*, it will, if Spence Bate be right, become an additional synonym of *Spirontocaris spinus*. To the same genus must apparently be referred two other British species, that which Bell calls *Hippolyte Cranchii*, Leach, and one named *Hippolyte pusiola* by Kröyer. Bell's species *pandaliformis* has been identified with the earlier *Hippolyte Gaimardii*, Milne-Edwards, above mentioned; J. Sp. Schneider records its occurrence in quite incredible numbers among algæ at small depths

in the arctic fiords of Norway. Lastly, Bell's *Hippolyte Thompsoni* belongs to a different family, having been identified with Rathke's *Pandalus brevirostris*.

Nauticaris, *Merhippolyte*, and *Amphiplectus*, are said by Spence Bate to differ from most of the other genera in the family by having a series of arthrobranchiæ which are elsewhere wanting, *Chorismus*, however, having a single pair.

Cryptocheles pygmæa, Sars, is only half an inch long, and owes its specific name to its small size, but the generic name, meaning 'with concealed chelæ,' refers to the unusual circumstance that in the first trunk-legs the chelæ are so small as to escape notice altogether without close inspection. This little species, found between 120 and 300 fathoms off the coast of Norway, brings forth its young in a condition to require no special metamorphosis.

Bythocaris resembles *Cryptocheles* in hatching the young with their full number of appendages, and in inhabiting very considerable depths. To this genus are now referred *Hippolyte Payeri*, Heller, and *Hippolyte Panschii*, Buchholz, besides the type species *Bythocaris simplicirostris*, Sars, *Bythocaris nana*, S. I. Smith, and a new one obtained by the Norwegian North Atlantic Expedition from 1,110 fathoms between Jan Mayen and Finmarken. All the species are northern or distinctively arctic, and the last, *Bythocaris leucŏpis*, Sars, is large and beautiful, being nearly four inches long, and in colour a magnificent rosy red.

Family 4.—Pandalidæ.

The rostrum is long and slender, more or less abundantly armed with teeth or spines. The eyes are well developed. The mandibles have a two- or three-jointed palp. The first pair of trunk-legs are not chelate, the second pair are chelate. The pleopods are biramous, the tail-fan is well developed and strong.

In this family Spence Bate discriminates seven genera. In two of these, *Chlorotŏcus*, A. Milne-Edwards, 1882, and *Dorodŏtes*, Spence Bate, 1888, he states that the second

pair of trunk-legs are uniform in length, while in the other five genera they are unequal. *Chlorotocus*, however, has the wrist of these legs two-jointed, while in *Dorodotes* it is six-jointed. The 'palp' of the mandibles is two-jointed in *Chlorotocus*, undescribed in *Dorodotes*, three-jointed in the other five genera.

Pandălus, Leach, 1814, has the 'anterior portion of the carapace carinated and produced to a long rostrum that is armed on the dorsal or upper surface with movable spines, intermingled with hairs, and on the lower surface with fixed and rigid teeth.' Also, the first pair of antennæ are not longer than the carapace, and the spine on the outer margin of their basal joint is obtusely pointed. Two British species belong to this genus, *Pandalus Montagui*, Leach, which has priority over the more generally used name, *annulicornis*, Leach, and *Pandalus brevirostris*, Rathke. There are numerous other species in various parts of the world, among which *Pandalus narwal*, Milne-Edwards, in the Mediterranean, exceeds a length of five inches. *Pandalus Montagui*, though its usual length is given by Bell as from two to two and a half inches, is said by S. I. Smith to attain a length between four and five inches off the coast of the United States.

Pandalopsis, A. Milne-Edwards, 1888, is most obviously distinguished from *Pandalus* by having the flagella of the first antennæ much longer than the carapace. The other genera are distinguished by some minute and curious characters, for while the frontal crest and rostrum of *Pandalus* are armed on the upper surface with movable spines only, in *Nothocăris*, Spence Bate, 1888, the dorsal crest has several spines that articulate in sockets, and several teeth that are fixed and rigid, but in *Plesionīka*, Spence Bate, 1888, and *Heterocarpus*, A. Milne-Edwards, 1881, there are teeth only, and no movable spines. In *Plesionika*, as also in *Nothocaris*, the spine on the outer margin of the basal joint of the first antennæ is large and pointed, but in *Heterocarpus* it is said by Spence Bate to be rudimentary; yet he identifies with the type species, *Heterocarpus ensifer*, A. Milne-Edwards, the *Heterocarpus*

carinatus of S. I. Smith, who says that the basal joint of the first antennæ is 'furnished externally with a large lamellar process terminating anteriorly in an acute angle in front of the eye,' a description ill-suited to the epithet rudimentary.

Legion 3.—*Monocarpinea.*

The wrist, or fifth joint of the second pair of trunk-legs, is not subdivided, and generally the chelæ of this pair are larger than those of the first.

Spence Bate arranges in this group eleven families—the Thalassocaridæ, Atyidæ, Pontoniidæ, Caricyphidæ, Acanthephyridæ, Palæmonidæ, Nematocarcinidæ, Tropiocaridæ, Stylodactylidæ, Pasiphæidæ, Oodeopidæ, among which the first differs from all the rest by having the first pair of trunk-legs simple, and the last differs from all the rest by having the second pair simple. The Tropiocaridæ do not seem to deserve a separate existence, without further consideration.

Family 1.—*Thalassocaridæ.*

The first trunk-legs are simple, the second chelate. Three genera are assigned to the family, one of them, *Diaphorŏpus*, Spence Bate, 1888, founded on what 'is evidently the immature condition of some undetermined form.'

Thalassocāris, Stimpson, 1860, takes the place of *Regulus*, Dana, 1852, the latter name being pre-occupied. The species as yet known belong to the Pacific, and are regarded as a link connecting the Pandalidæ with the Palæmonidæ.

Family 2.—*Atyidæ.*

The carapace is dorsally smooth, with flattened rostrum; the scale of the second antennæ short. The mandibles have a molar process and cutting edge, but no 'palp.' The third maxillipeds are four-jointed and pediform. The first and second trunk-legs are chelate, with spoon-shaped fingers. The telson is flattened, truncate.

There appear to be only two or three genera belonging to this family, and those confined to fresh water.

Atya, Leach, 1817, was called *Atys* in 1815, but the name was pre-occupied. It has in the first two pairs of trunk-legs the chelæ fringed with long hairs; the third pair are large and long, the fourth and fifth robust, shorter than the third. The genus *Atyoida*, Randall, 1839, is by Spence Bate considered a synonym of *Atya*, and he also seems to contemplate the possibility that species of *Caridina*, Milne-Edwards, 1837, may prove to be young stages of *Atya*. The latter genus includes several species, distributed in the islands of the Pacific and Atlantic, in New Zealand, and Mexico. *Atya sulcatipes*, Newport (see Plate X.), is found in the Cape Verde Islands, and is perhaps only a variety of the older *Atya scabra*, Leach, while *Atya serrata*, Spence Bate, also from the Cape Verde Islands, is said to exhibit only slight and unimportant differences from *Atya bisulcata* (Randall), which is found in the Sandwich Islands. The structure of the first two pairs of trunk-legs in this genus is not a little remarkable. The first joint has a tuft of long hairs set on a tubercle, and has a rudiment of an epipodal plate fringed with hairs; the third and fourth joints have hairy fringes; the fifth joint or wrist is short and crescent-shaped; but the chief peculiarity is in the arrangement of the sixth and seventh joints, which together have something of the form of a horseshoe magnet, the hand being articulated near its centre with the lower angle of the wrist, and both hand and finger have their flattened ends furnished with long finely ciliated hairs. 'When the hand is opened,' according to Fritz Müller, 'the hairs upon the margin of the fingers spread like a fan, gather and retain fine mud; when the hand is closed these hairs close round the mud and compress it into a pellet which is passed into the mouth, and so the animal lives on the small organic substances that exist in the mud, which it collects with great rapidity.' According to Mr. Spence Bate himself, 'these animals, of which the male is smaller than the female, as is frequently the case when they are not provided with offensive weapons, are only known to inhabit

fresh water, and, singular to relate, although they are inhabitants of distant localities, several of which are oceanic islands, yet all the species bear so close an affinity of form that it is difficult to determine one from the other by any permanent character.' To explain this distribution, it is suggested that ova may be carried in mud on the feet of wading birds, and by this means species transferred from one locality to another even over great distances. The ingenious theory, already referred to, by which Mr. Thomas Belt accounts in general for the wide distribution of freshwater species, does not seem applicable to those occupying oceanic islands. Genera related to *Atya* are *Atyephýra*, Brito Capello, 1867, for a Portuguese species, *Paratya*, Miers, 1882, conditionally proposed for the Japanese *Ephyra? compressa* of de Haan, *Troglocāris*, Dormitzer, 1853, which inhabits caves in Carinthia, and *Eratya*, S. I. Smith, 1872, which belongs to Central America.

Family 3.—Pontoniidæ.

The mandibles have a molar process and cutting edge but no 'palp.' The first pair of trunk-legs are subequal, slender, and chelate, the second unequal, one of the pair very large in the male.

Two genera are assigned to the family, both of which occur in the Mediterranean.

Pontonia, Latreille (1818), 1829, has the dorsal surface flattened, and the rostrum dorsally flat. There is no ocellus on the hind margin of the eye. The first antennæ have one of the two flagella bifid at the extremity, the second have a short but strong scale. The fully developed branchiæ are only four or five pairs. It is not correct to say that 'the telson carries no spine on the dorsal surface.' Several species certainly have them. In Australian specimens received from Mr. F. H. Haynes there are two pairs. The apical margin of the telson in the Australian species is fringed with six spines. The type species, *Pontonia custos* (Forskål), takes up its abode between the valves of a *Pinna*, and is supposed to be referred to by Aristotle when he says that a little shrimp (caridion) may take the

place of the little crab (carcinion) in companionship with the Pinna. In Australian and other Eastern waters, *Pontonia meleagrinæ* (Peters) occupies the shell of the pearl oyster, *Meleagrina margaritifera*, and probably also that of *Tridacna squamosa*. Professor Th. Barrois found the male and female of *Pontonia custos* constantly together in large specimens of *Pinna rudis* at the Azores.

Typton, Costa, 1844, though much like *Pontonia* in many points, has the dorsal surface arched and the rostrum laterally compressed, an ocellus on the hind margin of the eye, both flagella of the first antennæ undivided, the scale of the second rudimentary, and six or seven pairs of branchiæ. *Typton spongicŏla*, Costa, is, as its name implies, a lodger in sponges; it is a British as well as a Mediterranean species.

Family 4.—Caricyphidæ.

The rostrum is slender and sharp-pointed. The first antennæ have two short flagella, the second a long and narrow scale. The first two pairs of trunk-legs are chelate, subequal. Frequently the third segment of the pleon is dorsally elevated and compressed. The telson is long and slender. Here are placed three genera—*Caricȳphus*, 'the bowed shrimp;' *Rhomaleocāris*, 'the robust shrimp;' *Anēbocāris*, 'the immature shrimp,' all instituted by Spence Bate in 1888, and all from immature specimens, the largest of which was three-fifths of an inch in length. The seven species included in these three genera are all from Eastern and Southern waters. Though they will interest the specialist concerned with development, they seem but ill-suited to constitute a separate family.

Family 5.—Acanthephyridæ.

The animal is laterally compressed and dorsally carinate. The first antennæ have two long flagella; the second a sharp and rigid scale. The mandibles have molar tubercle, cutting edge, and 'palp.' The first two pairs of trunk-legs are slender, subequal. The telson is long,

narrow, and tapering to a truncate point. To this family belong apparently half a score of genera, almost all of which have been established within recent years. For the name of the family S. I. Smith's Miersiidæ has priority, but on the other hand the subfamily name Acanthephyrinæ is older than Miersiidæ, and moreover the species of *Miersia* which led to the use of the name Miersiidæ were subsequently transferred to the genus *Acanthephyra*, so that Acanthephyridæ would seem to be legitimate.

Acanthephўra, A. Milne-Edwards, 1881, is now represented by numerous species, practically from all parts of the world, except the Arctic regions, in the South reaching as far as Kerguelen Island. The species have been taken from great depths, seeming to descend even to nearly 3,000 fathoms. In the *Albatross* dredgings the species *Acanthephyra Agassizii*, S. I. Smith, which Spence Bate identifies with *Acanthephyra purpurea*, A. Milne-Edwards, was taken at forty-five stations ranging in depth from 105 to 2,949 fathoms, and since then a specimen has been taken alive in a dip-net, actually at the surface. From a deep haul off the Azores, at 1,675 fathoms, the *Challenger* obtained an example of which it is said, 'The specimen is beautifully preserved both in form and colour, the latter being of a rich crimson-lake, which suffuses every part of the animal. The hairs which fringe the legs are long, delicate, and generally planted perpendicularly to the surface.' The suggestion is made that this species is probably a free swimmer, able to range without inconvenience from one depth to another. In *Acanthephyra microphthalma*, S. I. Smith, the smallness of the eyes is considered to indicate that it is a truly abyssal species, in accord with the depths of a little more and a little less than 2,600 fathoms from which the specimens were obtained. There is always the chance that dredges and trawls with open mouths may catch a variety of animals while going down or coming up and not on the deep floor of the ocean, but the vast number of species which have only become known since deep-sea dredging commenced, makes it sufficiently clear that the general abode of the

majority of them is very far down in the waters, as otherwise they might just as well have been discovered earlier. *Acanthephyra sica*, Spence Bate, is as remarkable as any of the species for its range, the specimens taken by the *Challenger* coming from depths that varied between half a mile and over three miles, and from places so distant as New Zealand and Japan, Bermudas and the Falkland Islands. *Acanthephyra pellucida*, A. Milne-Edwards, is of a beautiful rose-colour in daylight and abundantly luminous in the dark.

Ephyrina, S. I. Smith, 1885, is distinguished from *Acanthephyra* by the unusual dilatation of the third and fourth joints of the last trunk-legs. The type *Ephyrina Benedicti*, Smith, was taken by the Albatross.

Oplophŏrus, Milne-Edwards, 1837, if the want of an aspirate be forgiven, is well named 'the bearer of heavy arms.' Especially this applies to the long and strong scale on the second antennæ, which tapers to a sharp point, and is described as capable of being rigidly locked in position and unfixed at will. It is judged that this weapon must be capable of inflicting a deep wound, which the serrate outer margin of the scale would render all the more dangerous. Spence Bate argues that the animal's power of progression must be great, for 'the teeth upon the dorsal surface of the pleon can be tightly compressed against the body; the appendages not utilised are capable of being drawn close to the animal, and its narrow form and polished sides seem fitted to enable it to shoot through the water.' With the rostrum and outstretched antennal scales it would, he thinks, be capable of a formidable attack on animals larger than itself, nor, when at rest, with these same weapons extended forwards and outwards, could it be easily approached, especially as the dorsal spines on the pleon would then be in a posture of defence in the rear, and on the flanks its strong integument supports and is defended by spines on the carapace and first pleon-segment. In the account of *Oplophorus typus*, Milne-Edwards, Spence Bate says:—'The most remarkable feature of the carapace is a lateral process on the posterior

margin that projects and lies beneath a corresponding process of the anterior margin of the first somite of the pleon, and bolts down the carapace so securely that it is difficult to elevate it.' Some of the other genera show a falling off from this vigorous character, for *Bentheocāris exuens*, Spence Bate, from 2,357 fathoms in the South Pacific, 'resembles many of the deep-sea forms in being soft and membranous,' and both *Hymenodōra*, Sars, 1876, and *Meningodōra*, S. I. Smith, 1882, alike signify 'a membranous skin,' the latter having for its type *Meningodora mollis* from the Atlantic, and the former having been instituted to receive *Pasiphaë glacialis*, Buchholz.

In describing *Hymenodora*, Sars observes: 'With the genus *Pasiphaë* its chief agreement consists simply in the two foremost pairs of feet being furnished with chelæ, and in all of the pairs having a natatory branch (exopodite); but this branch is far more powerfully developed than in the former genus, where it has merely the appearance of a rudimentary appendix. Moreover, the two foremost pairs of legs are considerably smaller, whereas the three succeeding pairs, which in *Pasiphaë* are small and feeble exhibit a powerful development. From the genus Pasiphaë it also differs by reason of its comparatively more thickset, almost rounded form of body, the unusually thin, membranaceous integuments, the rudimentary character of the eyes, the very different structure of the oral parts, and the peculiar form of the caudal appendages.' He looks upon it as 'marking in some respects a kind of transition to the Schizopod type,' an admission which Spence Bate would appear to have overlooked, since he does not refer to it in support of his own view that the Schizopoda should be included among the Macrura.

Spence Bate makes *Meningodora* a synonym of *Hymenodora*, to which he adds several species, placing it, together with *Notostŏmus*, A. Milne-Edwards, 1881, and his own new genus, *Tropiocāris*, 1888, in a separate family Tropiocaridæ. But as he says that *Tropiocaris* in many of its parts approximates so nearly to *Acanthephyra* and *Notostomus* that it can only be considered as a separate genus for the

convenience of classification, it seems hardly worth while for the present to separate the Tropiocaridæ from the Acanthephyridæ. *Notostomus* and *Gonatonōtus*, two genera established by A. Milne-Edwards in 1881, from the West Indies, are both said to be near *Oplophorus*, and both to have exopodal appendages to the feet. *Notostomus perlatus*, Spence Bate (see Plate XIII.), is from the Philippines.

Family 6.—*Palæmonidæ.*

The carapace is dorsally rounded and laterally compressed, the rostrum long, laterally compressed, and generally armed with teeth. The eyes are well developed and pyriform. The first antennæ have the basal joint dorsally hollowed, with a strong spine on the outer side, and frequently one of the flagella branched; the second pair have a long and narrow foliaceous scale, its rigid outer margin ending in a small tooth. The mandibles have molar tubercle and cutting edge, and either have or have not a 'palp.' The third maxillipeds are pediform.

The family includes about half a dozen genera, two of which are found in British waters.

Palæmon, Fabricius, 1798, has been subdivided since its institution, and Stimpson in 1860 rightly recognised that *Palæmon carcinus*, the first in the list of species assigned to the genus by Fabricius, should be the type. Hence the genus *Bīthȳnis* of Philippi, to which this and other fresh water species have been referred, is a mere synonym of *Palæmon*. The marine species, which have been commonly retained under the name *Palæmon* are referred by Stimpson to Desmarest's genus *Leander* with a fresh definition.

Spence Bate gives a synopsis of the genera into which the original *Palæmon* of Fabricius has been divided, which, with the necessary modifications, may be thus set out :—

Palæmon, Fabricius, 1798, has one tooth on the frontal margin of the carapace, and a second on the hepatic region nearly in the same horizontal line; the second trunk-legs with the wrist long.

Leander, Desmarest, 1849, has the frontal margin of

the carapace armed with two antennal teeth, one above the other; the second trunk-legs with the wrist long.

Palæmonella, Dana, 1852, has one tooth on the frontal margin, and a second on the hepatic region nearly in the same horizontal line; the second trunk-legs with the wrist not long.

Brachycarpus, Spence Bate, 1888, has one tooth on the frontal margin, and a second on the hepatic region, below the horizontal line; the second trunk-legs with the wrist short.

Palæmon carcinus is found in American rivers; *Palæmon lar*, the second in the list of Fabricius, in the East Indies. *Palæmon jamaicensis* has been obtained by Mr. Osbert Salvin from Lake Amatitlan, 'where it reaches a large size and forms an important article of commerce in the market at Guatemala.' Of *Palæmon heterochirus*, Wiegmann, Stimpson remarks that 'this is another of the large freshwater shrimps of Mexico. They frequently attain a length of two feet, including that of the chelopoda, which are at least as long as the body.' Other species range over the isles of the Pacific and Australia. In this genus the most striking feature is the elongation of the second legs in the male, which not infrequently even exceed the total length of the animal's body; a specimen of *Palæmon lar* may measure about five inches from the front margin of the carapace to the tip of the telson, and carry limbs eight inches long.

Palæmonella, Dana, has the rostrum slender instead of deep as in the other three genera, and the 'palp' of the mandible perhaps only two-jointed instead of three-jointed. Dana's two species *tenuipes* and *orientalis* are both from Eastern waters.

To *Leander* must be transferred the three species which Bell calls *Palæmon serratus* (Pennant), *Palæmon squilla* (Linn.), and *Palæmon Leachii*, Bell, the last of these becoming *Leander Fabricii* (Rathke). Norman now considers that his *Palæmon minans* from Guernsey, may be merely an abnormal specimen of *Leander squilla*. *Palæmon varians*,

Leach, was at one time called *Anchistia migratoria* by Heller. But it differs from Dana's *Anchistia* by having three flagella instead of only two on the first antennæ, and by having the two spines of the carapace one above instead of one behind the other. Heller therefore instituted for it in 1869 the new genus *Palæmonetes*, which agrees with *Anchistia* but differs from *Palæmon* in having no 'palp' to the mandibles. The development and larval metamorphoses of *Palæmonetes varians* have formed the subject of important studies by Dr. Boas, Mr. W. Faxon, and Dr. Paul Mayer. Its distribution has been summed up by Professor Th. Barrois. The same genus includes also the American fresh-water species, *Palæmonetes exilipes*, Stimpson, and *Palæmonetes vulgaris* (Say), which appears like *varians* to be almost equally at home in salt water and fresh. It affords an abundant supply of food to many of the fishes on the east coast of the United States, and is in turn itself supported with equal liberality by other animals. Messrs. Verrill and Smith, after speaking of its inhabiting the brackish pools and ditches, even where the water is but little salt, remark that it 'also occurs in immense numbers on the muddy bottoms and among the eel-grass of the estuaries. In the pools there are also myriads of small Entomostraca of many kinds, upon which the prawn and other species feed, while the Entomostraca find an abundance of ciliated Infusoria and other microscopic animals for food.' In regard to *Palæmonetes varians* an observation, perhaps generally applicable, was made by Hensen and confirmed by P. Mayer, that specimens in confinement will speedily shed their skins if well fed. The same authors showed also by very conclusive experiments that the animals after exuviation introduce fresh otoliths into the ear-cavity of the first antennæ. Dr. Mayer supplied crystallised silver, and had the satisfaction of seeing a bright scale of this metal in one ear of his young *Palæmonetes*. Hensen points out that the introduction of otoliths must as a rule take place while the softness of the new skin permits the narrow opening into the ear-chamber to be stretched to the utmost limit.

The species *Dennisia sagittifera*, Norman, 1861, from Guernsey, has since been identified with the Mediterranean *Anchistia scripta* (Risso). The earlier specific name is referred to letter-like markings on the underside of the female, the later one to a beautiful arrow-like mark on the back, Norman describing the pleon as 'very pale lilac. elegantly painted on the third segment with a chevron of a bright lilac.'

Family 7.—Nematocarcinidæ.

The animal is smooth and slender. The first antennæ have two long slender flagella, the second a long narrow scale and a long slender flagellum. The mandibles have a molar tubercle, cutting edge, and 'palp.' The trunk-legs have the fifth joint much longer than the sixth; the first two pairs are small and slender. The telson is slender and tapering.

Spence Bate places two genera in this family.

Nematocarcĭnus, A. Milne-Edwards, 1881, meaning the 'threadlike crustacean,' has a two-jointed mandibular 'palp,' a spoon-shaped terminal joint to the third maxillipeds, the second trunk-legs much longer than the first, and the three following pairs extremely long. The first antennæ are frequently three or four times the length of the animal. In the trunk-legs the articulation between the third and fourth joints is 'of peculiar and unique character, and seems probably adapted for the great muscular strain consequent upon the length of the joints.' The extremity of the third lies longitudinally under the fourth, so that these joints overlap and support each other. In the male the last three segments of the trunk have each ventrally a pair of flat anteriorly projecting plates or processes, only the middle pair being present in the female. The range of depth of the species, which are now numerous, seems to be from two or three hundred down to about two thousand fathoms, and the distribution extends over the Pacific and Atlantic, and to the Mediterranean. *Nematocarcinus ensifer*, S. I. Smith, was originally made the type of a new genus *Eumiersia*, which was afterwards recog-

nised as a synonym of *Nematocarcinus*. To this genus Spence Bate adds fourteen species from the *Challenger* collection. His *Nematocarcinus lanceopes* is from the Antarctic Sea. The delicacy of the framework in this genus sometimes makes fulness of description out of the question, as in the case of *Nematocarcinus altus*, Spence Bate, taken from 2,150 fathoms depth, south of the Philippines. 'Only one specimen of this species was procured, from which all the appendages are wanting, and the rostrum is broken near the apex.' *Nematocarcinus undulatipes*, Spence Bate, shown on Plate X., appears to be the commonest species.

Stochasmus, Spence Bate, 1888, means 'a conjecture,' the name alluding to the inconvenient circumstance that 'unfortunately only one very imperfect specimen was obtained; all the pereiopoda are gone, and its relation to *Nematocarcinus* can therefore only be conjectured.' It differs from that genus in having a 'dactylos' or seventh joint attached to the extremity of the third maxillipeds; in other respects it is in close agreement with it. It is said to differ from *Nematocarcinus cursor*, A. Milne-Edwards, only in the number and character of the spines on the rostrum.

Family 8.—Stylodactylidæ.

The second maxillipeds have a two-branched termination, and the first two pairs of trunk-legs have the arms of the chela, the so-called thumb and finger, long, slender, and feeble. There is but one genus in the family.

Stylodactylus, Milne-Edwards, 1883. The name evidently alludes to the very peculiar stiliform fingers in the chelipeds, and the spelling follows the old-standing confusion between the Greek word στῦλος, a pillar, and the quite distinct Latin word stĭlus, a pointed instrument. The genus occurs both in the Pacific and the Atlantic. The rostrum is a very long and conspicuous feature, in *Stylodactylus serratus*, A. Milne-Edwards, having forty spines on the upper and twenty on the lower margin, and being just upon an inch long in a specimen of which the entire length was two inches and three-fifths.

Family 9.—Pasiphæidæ.

The rostrum is small or obsolete, the mandibular 'palp' two- or one-jointed or wanting. The trunk-legs carry exopods. The third, fourth, and fifth pairs are inferior in size to the two pairs of chelipeds, the fourth being generally smallest of all.

Three genera are included in this family by Spence Bate, and a fourth has been established by S. I. Smith. One of these four is represented in British waters.

Pasiphæa, Savigny, 1816, was established in a rather casual manner in the footnotes to Savigny's celebrated 'Mémoires sur les animaux sans vertèbres,' to receive the Mediterranean species, *Alpheus sivado*, Risso, which also occurs in tolerably deep water off the coasts of England, Ireland, and Scotland. Bell says that Savigny gave no description of the genus, but he does in fact refer to the peculiarity that the appendages of the trunk exhibit exopods, as in species of *Squilla* and *Mysis*. Moreover, when insisting on the pediform character sometimes shown by the maxillipeds, he subjoins a note that 'the *Alpheus Sivado* of M. Risso has really twelve thoracic feet employed in locomotion.' Lastly, in a note to the description of the maxillipeds of an Amphipod, he observes that 'in *Alpheus Sivado*, the second joints of the two front chelipeds are united into the form of a lip, a peculiarity all the more remarkable for its occurring in only one of the sexes.' Subsequent writers do not appear to have repeated or explained this last observation. The figures of this species in Risso, in Bell, and in the completed edition of Leach's 'Malacostraca' (1875), are misleading as to the real shape of the animal, which is strongly bent at the middle. The mouth organs examined in a British specimen differ considerably from those depicted by de Haan for this species, but approach very closely those figured by Spence Bate for his *Pasiphæa cristata* from the Fiji Islands. In this genus the mandibular palp is wanting. The second maxillipeds are quite devoid of exopod, which Spence Bate notes as very unusual in the Macrura. Kröyer's *Pasiphæa*

tarda has the apex of the telson cleft instead of truncate. *Pasiphæa princeps* (S. I. Smith), 1884, obtained from a depth of 1,342 fathoms in the North Atlantic, is much larger than the type-species, since it attains a length of between eight and nine inches. The apex of the telson is cleft.

Leptochēla, Stimpson, 1860, is distinguished by having a short one-jointed mandibular 'palp,' and the second maxillipeds not pediform as in *Pasiphæa*, but with the last joint armed with long spines or hairs. The species are not large, *Leptochela robusta*, Stimpson, being only an inch long, and his *Leptochela gracilis* and Spence Bate's *Leptochela serratorbita* being still smaller.

Parapasiphaë, S. I. Smith, 1884, has a very small and slender mandibular 'palp,' composed of two nearly equal joints. In *Orphania tenuimăna*, Spence Bate, these organs were not examined, the specimen on which the genus and species were founded being 'unique and not very perfect.'

Family 10.—*Oodeopidæ*.

The carapace is short, produced to a long horizontal rostrum. The eye-stalks are short, the eyes large. The mandibles are without 'palp;' the third maxillipeds long, slender, and pediform. The first pair of trunk-legs are chelate or subchelate and larger than the second, which are simple.

This family was formed for a single genus, but may perhaps receive a second.

Oodeŏpus, Spence Bate, 1888, starts with seven species, but as they are all founded on immature animals, their actual characters remain vague, and with them those of the genus and family. The generic character makes the 'first pair of pereiopoda large and chelate,' but a following observation states that the most advanced specimen in the collection 'shows a tendency to develop the first pair of pereiopoda into a chela in the adult stage. All the other specimens exhibit them in the simple form,' which Spence Bate no doubt rightly takes to be a still more immature

condition. The genus is compared with *Rachitia spinalis*, Dana, a young animal taken in the Atlantic, which, however, differs 'in having the rostrum short, in the first pair of antennæ having only a single flagellum, and in the form of the telson.' The name *Oodeopus* perhaps alludes to the circumstance that in some of the specimens the feet were beginning to swell or bud out, but for swollen feet the Greeks had already provided the name *Œdipus*, and Dana had already used this name for another genus of prawns, and other naturalists had used it for other purposes before Dana. The alternative derivation of *Oodeopus*, as meaning 'with feet on the ground,' seems to make the name entirely pointless.

Autonomæa, Risso. 1816, may here be mentioned as a genus of which the position is obscure. It is described as having the first pair of trunk-legs chelate, the second simple. Risso distinguishes it from *Alpheus* and *Nika*. Milne-Edwards places it next to *Pontonia*, Victor Carus puts it between *Anchistia* and *Pandalus*. The type species was named *Autonomæa Olivii* by Risso, but as he makes *Cancer glaber*, Olivi, a synonym, it is hard to see why it should not be called *Autonomæa glaber*. Jonathan Couch in his Cornish Fauna is quoted by Adam White and Spence Bate as saying of it: 'This species has been hitherto unknown as British, but I have examined several specimens taken from the stomachs of fishes, from the depth of fifteen or twenty fathoms. Some of these were of larger size than described from the Mediterranean; one, not the largest, measuring three inches from snout to tail, with antennæ of the length of five inches.'

Legion 4.—Haplopodinea.

All the trunk-legs are similar in structure to each other, simple, six-jointed, with the fifth joint not subdivided, and all but the last pair carry exopods.

Family Hectarthropidæ.

As this is the only family, its characters are those of the legion. The four genera assigned to it were instituted at the same time as the family and legion.

Proclētes, Spence Bate, 1888, meaning 'Challenger,' is represented only by two specimens, the one here de-

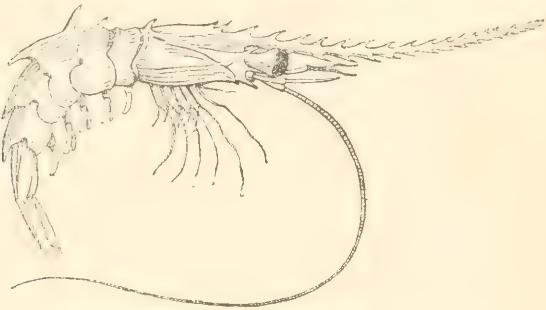


FIG. 21.—*Procletes biangulatus*, Sp. Bate [Chall. Rep.].

picted, which is just two-thirds of an inch long, and which is described as *Procletes biangulatus*, the other *Procletes Ellioti*, which has a smoother carapace, a shorter flagellum, and a longer telson, being described, it seems, only from a drawing, not from the original specimen taken by the late Sir Walter Elliot, years ago, off the coast of Coromandel.

Icotŏpus and *Hectarthropus* proclaim their adhesion to the family by the meanings of the names, the former signifying 'with similar feet,' the latter 'with six-jointed feet.' The fourth genus which Spence Bate establishes in this family, *Eretmocāris*, 'the oar-shrimp,' in allusion to the provision of exopods or swimming-branches, is presumably founded on immature specimens, since it is observed that 'the first three pairs of appendages in this genus, the eyes and two pairs of antennæ, are attached to a portion of the cephalon projected in front of the carapace, which still retains the embryonic ocellus.' The animals have a very striking appearance from the unusual and

surprising length of the eye-stalks. This reaches its maximum in *Eretmocaris longicaulis* (see Plate XIII.), so far as comparative measurements are concerned. The specimen, it is true, is less than a quarter of an inch long, if the eyes are not counted in, but the length is doubled if they are, for these stalked eyes are more than a quarter of an inch long, a proportion between the organ of vision and the rest of the body which probably no other animal in the world can boast of.

In quitting at this point the assistance of Mr. Spence Bate's 'Report on the *Challenger* Macrura,' it is right to pay a tribute to the vast labour which that work must have involved, and to the great ability shown in it although amidst many inaccuracies and much want of method. Unfortunately the nomenclature which Mr. Spence Bate adopted makes it sometimes more difficult to read his descriptions than those written in a foreign tongue. He formed the grand conception of giving one invariable name to each part of a crustacean, as it might appear under every possible modification, throughout the whole class. For the comparative anatomist no scheme could be more valuable, but for the students of different orders there is always the chance that such an arrangement will be irritating and repellent. The name that may commend itself as obvious and natural in one group becomes wholly inappropriate in another. Supreme skill might override many difficulties by inventing terms of great simplicity, not inappropriate to any group by being especially appropriate to none. But simplicity seems to have been the very last thing considered in Spence Bate's terminology, and though such words as phymacerite, psalistŏma, and stylamblys, may help to curtail the length of descriptions, they are only too likely also to curtail the number of those that read them.

CHAPTER XVIII

SUB-ORDER III.—SCHIZOPODA

THE mandibles have generally an elongate 'palp.' The second and third maxillipeds are similar in general structure and function to the series of trunk-legs, the whole seven pairs of appendages, and in general the first maxillipeds also, being provided with well-developed exopods or swimming-branches. There are no chelipeds. The ova are carried by the female beneath the trunk, either with or without the protection of marsupial plates, and generally one or two of the larval stages are passed through before the hatching of the young animal. The males are generally distinguished by a special appendage on the first antennæ and by larger pleopods.

The name Schizopoda, 'cleft-footed,' refers to the double character borne by so many of the appendages, in which the main stem or endopod is more or less ambulatory and the exopod is adapted for swimming. The affinity which the Schizopoda show to some of the Macrura, such as the Pasiphæidæ, and the definite opinion of Mr. Spence Bate that they ought to be included as an aberrant group among the Macrura dendrobranchiata, have been already noticed. Whether they should stand just inside or just outside the sub-order of the Macrura, is a nice point of classification for the learned to decide.

Four families are at present included in the Schizopoda, the Lophogastridæ, Eucopiidæ, Euphausiidæ, and Mysidæ. But on the one hand a suggestion has been made that two forms hitherto assigned to the Mysidae may require the institution of a separate family, and on the other hand Mr. G. M. Thomson, the well-known naturalist of

Dunedin, New Zealand, has informed me by letter that among specimens which he collected in Tasmania during January, 1892, 'one is especially interesting, a freshwater Schizopod from the very summit of Mount Wellington, that is, from a height of 4,000 feet, and that this crustacean is quite unique, and will require a new family all to itself.' Writing again, he tells me that the animal has no carapace, but is divided like an amphipod, so that he has named the genus *Anaspis*, which means 'without a shield.' From the available information, therefore, it is not difficult to predict that the number of Schizopod families will in the near future be augmented from four to six.

Family 1.—*Lophogastridæ.*

The carapace is rather large, more or less calcareous, loosely covering more or less of the trunk, the segments of which are well defined dorsally. The first maxillipeds are robust, with exopod imperfectly developed or wanting, the epipod very large and projecting within the branchial cavity. The second maxillipeds have the terminal joint obtuse. The six following pairs of appendages are uniform and ambulatory, with well-marked finger. The branchiæ are arthrobranchiæ, very complex, arborescent, consisting of three or four principal branches, the innermost largest and freely projecting beneath the trunk, and of others covered by the carapace; the hindmost pair are rudimentary or wanting. The marsupium or maternal pouch consists of seven pairs of plates. The pleopods are well developed in both sexes, uniform, natatory. The development is without any free metamorphosis.

G. O. Sars, from whose exceedingly valuable report on the *Challenger* Schizopods this definition is adapted, allots four genera to this family.

Lophogaster, Michael Sars, 1856, still possesses but a single species, *Lophogaster typicus*, M. Sars, which at present is only known from the North Atlantic and the South Atlantic, without having been discovered in intermediate positions. It is recorded by Canon Norman from the Shetland Isles. Its sculptured carapace has a short

and broad tridentate frontal plate, and leaves the last segment of the trunk dorsally uncovered. The scale of the second antennæ is broad and heart-shaped with a fringed inner margin. The elongate telson terminates in some strong spines and a little serrate plate.

Ceratolĕpis, G. O. Sars, 1883, has also only one species, *Ceratolepis hamata*, which much resembles the preceding, but its hard and large carapace leaves no segment of the trunk uncovered. The scale of the second antennæ is narrow and flexuous, forming a sort of hook on either margin, with no fringe of hairs, and the telson is not truncate at the apex but cleft into two diverging lappets, 'somewhat resembling the tail of a swallow.' The single specimen was scarcely half an inch long, and hence the smallest of the known Lophogastridæ, and, though its organisation seems to mark it out as a deep-sea form like the rest of the family, it was in fact taken at the surface of the Pacific.

Gnathophausia, v. Willemoes Suhm, 1879, has a parchment-like integument, the carapace in front drawn out into a long spear-shaped and denticulate rostrum, and behind in general into a backward pointing spine. 'The greater part of the carapace, as in the genus *Nebalia*, would appear to form, so to speak, merely a loose mantle arching the back and sides of the trunk, and within which the body is freely movable.' This part is surmounted by two longitudinal keels on each side. On the upper side of the eye-stalk there is always a small prominence called the ocular papilla. Of the first antennæ the outer flagellum is very long and so compressed as to be almost ribbon-shaped. The scale of the second antennæ is variable. The first maxillæ have on the outer side of the basal part a two-jointed 'palp,' which, contrary to what is the case in the other Podophthalma, is bent directly backwards. Though looking like an epipod, this appears to be part of the endopod. Both joints are armed with setæ or bristles, those on the second joint elongate, the apparatus being no doubt destined to sweep the branchial cavity, as is the case with the similar formation in the

Cumacea and some of the Isopoda. The second maxillæ exhibit exteriorly at the base a very conspicuous mammilliform prominence, which Sars supposes to be a phosphorescent organ. Dr. v. Willemoes Suhm considered it an accessory eye, and hence gave the genus a name meaning 'light in the jaw,' which is equally appropriate to the new explanation of this curious prominence. The lamellar exopods of these maxillæ fit pretty closely into the lateral emargination of the carapace at each side of the buccal area, 'forming, as it were, a kind of piston, by the oscillatory movements of which the postero-anterior current of water produced beneath the free portion of the carapace may be regulated.' The first maxillipeds have the basal part much widened, the indistinctly separated second joint in some species carrying a rudimentary exopod, but not in others; the basal joint has an epipod, a freely movable membranous plate, projecting within the branchial cavity. This, 'as in *Lophogaster*, is of very considerable size, almost equalling in length the whole maxilliped, and exhibits a narrow lanceolate form, the apex being somewhat recurved. Its function, too, is more properly to produce, by its rhythmical movements to and fro, the current of water flowing beneath the free portion of the carapace, and bathing the gill-branches attached outside the bases of the legs.' The seven following pairs of appendages have the fifth joint elongate, the exopod developed into a powerful swimming branch, of which the base is muscular and the terminal part multiarticulate and setiferous. The complex branchiæ are strongly developed at the bases of all the pairs, except the last, on which they are small and rudimentary. The pleopods in both sexes are developed in the same manner as powerful swimming organs. The sixth segment of the pleon has a transverse suture, as in *Lophogaster*. The telson is large, channelled along the middle, and after tapering to the apex there ends in an almost semilunar projection. Of this strange genus nine species are now known, ranging in depth from 255 to 2,200 fathoms, and over almost all the ocean. The first species described was called *Lopho-*

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gaster ingens by Dr. Dohrn in 1870. This is the largest species, the specimens measuring rather more than six inches, while those of *Gnathophausia gigas*, v. Willemoes Suhm, measure rather less than six inches. Vivid red and magnificent carmine appear to be the prevalent colouring in the genus. It is probable that the two species mentioned, together with two others, *calcarata*, Sars, and *gracilis*, v. Willemoes Suhm, will be eventually retained in this genus to the exclusion of the other species, which are destitute of the rudimentary exopod on the first maxillipeds.

Chalaraspis alata is accepted by Sars from the drawings and manuscript notes of v. Willemoes Suhm, but there was no specimen in the *Challenger* collection by which to control these records.

Family 2.—*Eucopiidæ.*

The carapace is very large, membranous, with the lateral margins produced over the base of the pleon. The segments of the trunk are all well defined. The first maxillipeds are nearly as in the Lophogastridæ; the three following pairs of appendages are inclined towards the parts of the mouth, and have a rather short and powerful structure, while the next three pairs are exceedingly long and slender, with nearly straight acute fingers, the remaining pair being shorter and less slender, not at all prehensile. The branchiæ, marsupium, and pleopods are nearly as in the Lophogastridæ. The development is unknown.

The family contains but one genus.

Eucopia, Dana, 1852, has but a single species, *Eucopia australis*, Dana. This has no rostrum; the eyes are small, the scale of the second antennæ large, the mandibular 'palp' very slender, the first maxillæ with no reflexed appendage, the second with a very large strongly fringed exopod. The first maxillipeds have a rather small exopod, but the epipod 'enormously developed, lanceolate in form, and of a very soft and almost spongy structure.' The three pairs of legs preceding the last, remarkably long and

slender as they are, would not seem, it is said, 'to be specially adapted for the usual ambulatory motion, but are more likely used for the purpose of seizing hold of any delicate submarine objects, as Hydroids or Crinoids, fixed at the sea bottom.' In preserved specimens these limbs are geniculate between the third and fourth joints. Their fingers, though nearly straight, bend back against the spines of the preceding joints, and may thus be very efficiently prehensile. Dana's specimen was obtained from the stomach of a penguin in the Antarctic ocean, a habitat which gave little reason to suspect the actual distribution of the species. According to the *Challenger* researches it ranges from Japan to the Southern Ocean and from the Southern Ocean to Nova Scotia, preferring depths between 1,000 and 2,000 fathoms, though descending lower and mounting higher. It is presumed that the specimen snapped up by the penguin must have made an excursion to near the surface.

Family 3.—Euphausiidæ.

The carapace is rather small, not calcareous, firmly connected with the trunk dorsally, only the last segment being completely defined above. The first maxillipeds are pediform, elongate, with well-developed natatory exopod, the epipod rudimentary or wanting. The seven following pairs of appendages are generally uniform in structure, not effectively ambulatory, geniculate and densely setose, without any distinct finger, the hinder pairs more or less imperfectly developed. The branchiæ are podobranchiæ, wholly uncovered, digitiform-arborescent, the hinder pairs rather complex, sending off a branch beneath the trunk. The egg-pouch, when present, is under the hinder part of the trunk, single or double, not formed by marsupial plates. The pleopods are strongly developed in both sexes, natatory, with a secondary lobe on the inner branch; the first two pairs are sexually modified in the male. The telson is very slender, tapering to an acute point, and carrying two large spiniform slightly divergent appendages, affixed at some

distance from the apex, but generally reaching much beyond it. Luminous globules are generally present on various parts of the animal. The heart is furnished with six pairs of lateral slits or venous openings. The development is complex, the larva after hatching passing through the Nauplius- and Zoëa-stages.

Eight genera are included in this family, three of which are represented in the British Fauna.

Euphausia, Dana, 1852, which means 'a bright light,' was so called in reference to the luminous character which all the species of this genus share with most others in the same family. This genus is distinguished from the rest by having the last two pairs of legs quite rudimentary, although the branchiæ are well developed. By the numerous species it is almost universally distributed. It is pelagic in habit, that is to say, its members occupy the surface of the ocean when it suits them. They may or may not descend to great depths, but often, and especially at night time, they are to be found in great profusion at the surface. *Euphausia pellucida*, Dana, a colourless species, was met with 'in almost every tract of the ocean traversed by the *Challenger*,' and has also been taken in the Mediterranean and off the coast of Norway. *Euphausia superba*, Dana, from the Antarctic Sea, has its whole body, except the legs and branchiæ, tinged with a brilliant red. The luminous globules in these animals were at one time supposed to be accessory eyes, but Sars regards them as constituting 'a very complicated and peculiarly developed luminous or phosphorescent apparatus.' They are 'very conspicuous in the living animal by reason of their beautiful red pigment and glistening lustre.' The pigment coats only the hinder half of the globule, which is filled up with cellular matter enclosing a bunch of iridescent fibres, while the front hemisphere is quite pellucid and contains a highly refractive lenticular corpuscle. This last is supposed to act 'as a condenser, producing a bright flash of light, the direction of which admits of being changed at the will of the animal, by simply rolling the organ by means of its muscular apparatus.'

[*Boreophausia*], G. O. Sars, 1883, has the basal joint of the first antennæ without an apical leaflet. It was established to receive two northern species, which had been successively placed in the genera *Thysanopoda* and *Euphausia*, and which are now *Boreophausia inermis* (Kröyer) and *Boreophausia Raschii* (Michael Sars). Both are found in Scottish waters, and since Norman identifies *Boreophausia Raschii* with *Rhoda Jardineana*, G. Sim, 1872, it seems that the generic name ought to be *Rhoda*.

Thysanopŏda, Milne-Edwards, 1830, has only the last pair of legs rudimentary, and even these have a well-developed exopod; the last pair but one are like those that precede them. All the true branchiæ are provided with an anteriorly bent branch. The type species is *Thysanopoda tricuspida*, Milne-Edwards. The British species *Thysanopoda Couchii*, Bell, and various others have been transferred to different genera.

Nyctiphănes, G. O. Sars, 1883, which means 'one that shines by night,' like *Thysanopoda*, has only the last pair of legs rudimentary, but the preceding pair are a little imperfect, being devoid of the three terminal joints. In both pairs the exopod is developed in the male, but wanting in the female. The basal joint of the first antennæ carries a peculiar reflexed leaflet at the apex. *Nyctiphanes norvegica* (Michael Sars) is reported from the Firth of Clyde as abundant and fine everywhere in deep water, on a muddy bottom, as far up as Loch Goil. Young specimens are said to be not uncommon at the surface in the Firth of Forth, especially in winter and spring. In certain districts it forms an important part of the food of the herrings. A specimen has been taken alive on the shore at low water in North Devon. *Nyctiphanes Couchii* (Bell) is distinguished from the preceding species by having no lateral spines on the carapace and by having a spine over the base of the telson. It is recorded from Cornwall and Banff. Very like it is *Nyctiphanes australis*, Sars, which appears to be restricted to the Australian seas. In describing this species Sars says that two of the female specimens were ovigerous, a condition seldom met with

among preserved specimens of Euphausiidæ. The two conical ovisacs, placed side by side between the last two pairs of appendages of the trunk, 'do not consist of incubatory lamellæ, as in other Schizopoda, but merely of an exceedingly thin membrane, derived, it would seem, from some glutinous fluid issuing along with the ova and coagulated by the action of the sea-water as a delicate envelope surrounding and keeping the ova together during the embryonal development.' The curious fact is noticed that of the northern species the specimen of *Nyctiphanes Couchii* figured by Bell in his 'History of British Crustacea' is the only ovigerous one that has as yet been recorded.

Bentheuphausia, Sars, 1885, has all the legs distinctly developed, and though the last pair are rather short, they have both branches of a structure similar to that of the preceding pairs. The single species, *Bentheuphausia amblyops*, Sars, has small and imperfectly developed eyes. The three specimens on which it was founded were taken from depths between 1,000 and 1,800 fathoms, and appear to be devoid of the luminous globules found in so many other members of this family.

Thysanoessa, Brandt, 1851, has the last pair of legs quite rudimentary, and the preceding pair exceedingly small, devoid of the three terminal joints. On the other hand, the second maxillipeds are very elongate, much longer than the following legs. They have the last two joints armed with spiniform bristles on both margins. The eyes in this genus are of a somewhat irregular form, with the cornea divided, as it were, into two compartments by a transverse constriction. The type species, *Thysanoessa longipes*, Brandt, from the Siberian Sea, is identified by Norman with the earlier *Thysanopoda neglecta*, Kröyer. Sars has added a southern species, *Thysanoessa macrura*; a wide-ranging species, *Thysanoessa gregaria*, which is found in the Mediterranean; and two from the coast of Norway, which he has named *borealis* and *tenera*. Dr. H. J. Hansen, however, having examined Kröyer's specimens in the Copenhagen Museum, has come to the conclusion that *Thysanoessa borealis*, Sars, should be called *Thysanoessa*

neglecta (Kröyer), and that *Thysanoessa tenera*, Sars, should be named *Thysanoessa longicaudata* (Kröyer). The latter species was supposed by Sars to belong to his genus *Boreophausia*, on the faith apparently of Kröyer's figures drawn from a defective specimen. Both *neglecta* and *longicaudata* are known from British localities.

Nematoscĕlis, Sars, 1883, agrees in many respects with *Thysanoessa*, but has the second maxillipeds, or first legs, as Sars calls them, far more remarkably elongated and almost filiform. In the type species, *Nematoscelis megalops*, Sars, they are described as having little or no armature, except a bunch of peculiar spiniform setæ at the apex. But Norman points out that in British specimens the fourth joint has several hooked spines, which look as if they might hold the sixth joint when bent back upon the fourth. Should this form hereafter prove distinct, he proposes for it the name *borealis* already published, but without description, in 1872. The genus is distinguished by the enormous development of the eyes, 'of larger size, perhaps, than in any other known form of Podophthalmia,' the remark applying to the actual eyes, and not to the stalks, which are quite short.

Stylocheiron, Sars, 1883, has the third maxillipeds, or second legs, greatly produced, the two terminal joints being armed with spiniform bristles and spines, and the two forming together a kind of grasping organ. The last pair of legs are quite rudimentary, and the two preceding pairs are incomplete. In this genus the mandibles have no 'palp,' the first maxillæ no exopod, and the first maxillipeds no epipod. The ovisac is single. One of the species, *Stylocheiron longicorne*, Sars, has been taken both in the Mediterranean and south of the Cape of Good Hope. Chun notes that in his *mastigophŏrum* the luminous organs are bright red.

Messrs. G. Brook and W. E. Hoyle follow up the labours of Claus, Metschnikoff, and Sars, by tracing the Euphausid larva through seven stages—(1) the *Nauplius*, with body oval, unsegmented, median unpaired eye, first antennæ (long) simple, second antennæ (long) and man-

dibles (short), both the latter being biramous and natatory; (2) a second *Nauplius* stage, in which maxillæ and maxillipeds appear as bud-like rudiments; (3) *Metanauplius*, with the carapace commencing, and the mandibular legs lost; (4) *Calyptopis*, with body divided into two regions, and much other development, but eyes not mobile, and no trace of legs or pleopods; (5) an unnamed intermediate stage, in which the eyes become stalked and mobile; (6) *Furcilia*, with the compound eyes more fully developed, and the anterior legs and pleopods taking form; (7) *Cyrtopia*, in which the flagellum of the first antennæ becomes elongate and distinctly articulate, so that these appendages cease to serve the purposes of locomotion. 'In their metamorphosis,' the authors say, 'the Euphausiidæ stand almost alone, and none of the later larval stages are identical with the Zoea and other larvæ of Decapods. They commence their larval life in the Nauplius condition, a type of larva frequent in other groups, particularly among the Copepods, Cirripedes, some Decapods, and various parasitic forms. The larval function of the antennæ is retained until the commencement of the Cyrtopia stage, a feature which is not usual among the Crustacea. The Calyptopis stage, in which the compound eyes, while undergoing development, are covered by an anterior expansion of the carapace, is a remarkable one, which, so far as we know, is only met with in one other group, an aberrant section of the Decapods, including *Lucifer*, &c., where this condition obtains in the Protozoea stage.' The names of the so-called *Calyptopis*, *Furcilia*, and *Cyrtopia* stages have been adopted from three supposed genera, established by Dana, who assigned the first two to the Mysidæ, and the third to the Euphausiidæ, all of them, in fact, representing stages in the development of the latter family.

Family 4.—*Mysidæ.*

The carapace is generally rather small, loosely covering the trunk behind, of which the segments are distinctly defined, though narrow and crowded dorsally. The first

maxillipeds have usually a natatory exopod, and an epipod projecting within the branchial cavity. The second pair are modified to serve the mouth. The remaining appendages of the trunk are uniform, rather feeble, the terminal part generally subdivided into short setiferous articulations, the finger being small or wanting. There are no true branchiæ. The marsupium is composed of seven or more often of only two or three pairs of plates. The pleopods in the female are as a rule quite rudimentary, in the male either natatory or modified for sexual purposes. The inner branch of the uropods usually contains an auditory apparatus. The development is without any free metamorphosis.

The eighteen genera included in this family by Sars in 1885 are *Mysis*, Latreille, 1803, *Siriella*, Dana, 1850, *Promysis*, Dana, 1850, *Anchiălus*, Kröyer, 1861, *Heteromysis*, S. I. Smith, 1874, *Petalophthalmus*, v. Willemoes Suhm, 1879, and the following twelve all instituted by Sars himself, *Amblyopsis*, *Boreomysis*, *Erythrops*, *Hemimysis*, *Leptomysis*, *Mysideis*, *Mysidopsis*, *Parerythrops*, *Pseudomma*, under the common date of 1869, *Mysidella*, 1872, *Macropsis*, 1876, and *Euchætomĕra*, in 1883. The list (no doubt accidentally) omits a nineteenth genus, *Pseudomysis*, Sars, 1880, and a twentieth, *Gastrosaccus*, Norman, 1869, from which yet another has been severed in *Haplostylus*, Kossmann, 1880. From *Siriella* Claus has separated *Pseudosiriella*, in 1884. From *Mysideis* Norman in 1892 distinguishes *Stilomysis*, and in the same year recognises *Macromysis*, White, 1847, *Neomysis*, Czerniavsky, 1882, and a new genus *Schistomysis*, as distinct from *Mysis*. Thus with *Arctomysis*, Hansen, 1887, added since Sars drew up his list, and with *Arachnomysis*, Chun, the number of genera, if all are accepted, amounts to twenty-eight. But further, Norman has called my attention to Czerniavsky's Monographia Mysidarum, 1882–3, in which several new but not always well-founded genera appear. One of these preoccupies the name *Arctomysis*, so that Hansen's genus must be re-named. *Macromysis* also must yield to the rather queer but much earlier generic name *Praunus*, Leach, 1813, of which the

unabashed author himself remarks that 'this genus was instituted by Mr. Leach, who has derived the name from the English word *prawn*.' He assigned to it the species *flexuosus*, Müller, and *integer*, Leach.

Petalophthalmus was so called from having the eyes leaf-like. They are described in the single species, *Petalophthalmus armiger*, as 'quite rudimentary, without any trace either of pigment or visual elements, constituting merely two thin and pellucid lamellæ, of an oblong form, and mounted on very short and narrow pedicles.' The species was obtained in the tropical Atlantic from a depth of 2,500 fathoms. The telson is not incised at the apex. The male is distinguished by the astonishing and perhaps unique development of the mandibular 'palp,' and by the lamellar prolongation of the fourth joint in the first and second maxillipeds, the first pair being, contrary to the custom in this family, devoid of exopod and epipod. A female with seven pairs of marsupial plates has been, perhaps incorrectly, assigned to this species.

For the preoccupied *Arctomysis*, Hansen, I propose the name *Hansenomysis*. It has a short carapace, the mandibles with prominent cutting edge, long molar tubercle, and very large 'palp,' the first maxillipeds without exopod, and with none of the joints expanded, but with an epipod, the second maxillipeds with a small ovigerous plate at the base, and the short fourth joint expanded into a large plate. The three following pairs of appendages are very slender, with a short hairy terminal joint, and there is a very long, sharp, bare nail on the next three pairs. Hansen considers that his *Hansenomysis Fyllæ* and the *male* of v. Willemoes Suhm's *Petalophthalmus armiger* might form a separate family in the Schizopoda. The supposed female of the latter species he regards as belonging to *Boreomysis scyphops* and not to *Petalophthalmus*.

Boreomysis, of which the type species is *Boreomysis arctica* (Kröyer), taken off the coasts of Greenland and Norway, includes among others *Boreomysis scyphops*, Sars, which is far from being only a boreal Mysis. It was in fact first met with by the *Challenger* at great depths in the

Southern Ocean, in 1,950 fathoms, at latitude 53° 55′ south, but afterwards it was taken at a depth of 1,110 fathoms, north-west of Finmark, by the Norwegian North Atlantic Expedition. This is one of the instances in which a species has only been found far to the north and far to the south, yet it seems hasty to infer that such species will not in time be discovered in many intermediate localities. *Boreomysis scyphops* is gigantic for a Mysidan, attaining a length of more than three inches. In this genus there are seven pairs of marsupial plates, which are attached to the second maxillipeds and the following limbs. Apparently all the rest of the Mysidæ are content with a much smaller number of incubatory lamellæ. *Boreomysis* is without the abnormal characters of the male found in *Petalophthalmus*, and it has the telson apically incised.

Amblyopsis was altered into *Amblyops* by Sars in 1872. The name has reference to the character of the eyes, which are 'imperfectly developed, transformed into two immobile plates, extending horizontally in front of the carapace and contiguous in the middle.' There are only two species, the Norwegian *Amblyopsis abbreviata*, and from the Southern Ocean *Amblyopsis crozetii*. In this genus the legs are tolerably strong, having the sixth joint subdivided into three articulations, and the terminal joint unguiform; the telson is not incised at the apex.

Pseudomma has the 'eyes quite rudimentary, forming merely broad petaloid expansions of the ocular segment, partly connate in the middle, and not exhibiting the slightest trace of pigment or visual elements.' Here the legs are exceedingly slender, the sixth joint subdivided as in the preceding genus, but the terminal joint obtuse, not unguiform. The telson is not incised. Three northern and two southern species have been described, *Pseudomma truncatum*, S. I. Smith, being arctic, and *Pseudomma Sarsii*, v. Willemoes Suhm, antarctic.

Mysis, as understood prior to the recent restriction of the genus, has the sixth joint of the trunk-legs subdivided, and the fourth pair of pleopods in the male developed into long backward-directed stilets, the third pair being also

generally unlike those in the other sex, but the three remaining pairs usually simple and rudimentary like the pleopods of the female. The telson is either incised or whole at the apex. The very numerous species may be distinguished by the general shape, by the structure of the scale of the second antennæ and its size in relation to the peduncle of the first antennæ, by the number of articulations in the subdivided joint of the trunk-legs, by the shape of the telson and its length in relation to the uropods, and by the structure of the fourth pleopods in the male.

Several of the species occur in British waters, but only two of them are definitely described in Bell's 'History of the British Stalk-eyed Crustacea,' namely *Mysis flexuosus* (Müller), under the name of *Mysis chamæleon*, J. Vaughan Thompson, which has the telson incised, and *Mysis vulgaris*, Vaughan Thompson, which has the apex of the telson undivided, and which may be the same as the *Praunus integer* of Leach, from Loch Ranza. *Mysis neglecta*, Sars, has been taken by Norman at the Channel Islands, and is reported by Dr. Henderson from the Clyde. Meinert does not feel sure that it is distinct from *Mysis flexuosus*, he having often met with individuals which seemed to be links between the two. Norman groups them both with *Mysis inermis*, Rathke, a species found in Shetland, observing that all three are distinguished by an antennal scale which is long, lanceolate, subparallel-sided, and having the apex scarcely produced beyond the unciliated external margin, but that in *flexuosus* the scale is seven or eight times as long as broad, in *neglecta* about five times, in *inermis* about four times. *Mysis spiritus*, Norman, has the eyes on long stalks, the spines on the inner branch of the uropods closely crowded, the fourth pleopods in the male 'with the first three joints subequal in length, and the last joint subequal to the fourth.' On the other hand, *Mysis ornata*, Sars, has the eyes short, the spines on the inner branch of the uropods not crowded, the fourth pleopods in the male, with 'the outer branch very like that of *M. spiritus*, but the third joint is much longer than either of the two first, which are subequal; fifth joint not

more than half the length of the fourth.' *Mysis Helleri*, Sars, a Mediterranean species also found at the Channel Islands and on the coast of Devon, is very like in general character to *Mysis spiritus*, from which, Norman observes, it may be at once distinguished by the very short and nodulously swollen first articulation of the subdivided sixth joint in the trunk-legs. *Mysis Lamornæ*, Couch, has the telson deeply but narrowly cleft. *Mysis arenosa*, Sars, is a small species in which the pleon is shorter than usual, the eyes are short, the fourth pleopods of the male do not reach the apex of the telson, the incision in the telson is about one-fourth of its length. This species, first described from the Mediterranean, has since been found in South Devon and in Scotland. Thus nine species of the genus have been assigned to the British Fauna. In the 'Annals and Magazine of Natural History' for September, 1892, Canon Norman has distributed these species among four genera, in which the distinctions depend chiefly upon the remarkable and varied modifications of the pleopods in the male sex, and upon the form of the antennal scale. Under this arrangement the species *flexuosus*, *neglecta*, and *inermis*, are referred to *Macromysis*; *spiritus*, *ornata* (including *Kervillei*), *arenosa*, *Helleri*, and *Parkeri*, to *Schistomysis*; and *vulgaris* to *Neomysis*. *Mysis Lamornæ* is transferred to *Hemimysis*. As already observed, for *Macromysis* must be substituted the older name *Praunus*. The species *Parkeri*, Norman, 1892, from South Devon, is a new one. It is very near to *Schistomysis spiritus*, from which it may be distinguished by the more twisted and bent inner uropod, armed with about fifteen spines on the inner margin, increasing in size from the base of the appendage. In *Schistomysis* the antennal scale is sub-rhomboidal, with the apex greatly produced beyond the spine of the unciliated external margin; in *Neomysis* this scale is ciliated on both margins, and runs out to a spine-like apex. The species *Themisto longispinosa*, Goodsir, and *Themisto brevispinosa*, Goodsir, from the Firth of Forth, are evidently male forms of the genus *Mysis*, but their specific identity has not been determined. The generic name *Themisto* is preoccupied.

The Greenland species, *Mysis oculatus* (O. Fabricius), is of special interest on account of the variety *relicta*, Lovén, found in great hordes in several of the large freshwater lakes of northern Europe, descended, it is supposed, from ancestors which occupied those regions when the waters were still salt and in connection with the open sea. In *Mysis relicta* the antennal scale is elongate, ciliated all

FIG. 22.—*Mysis relicta*, Lovén, the first maxilla [Sars].

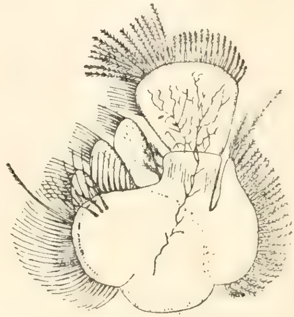
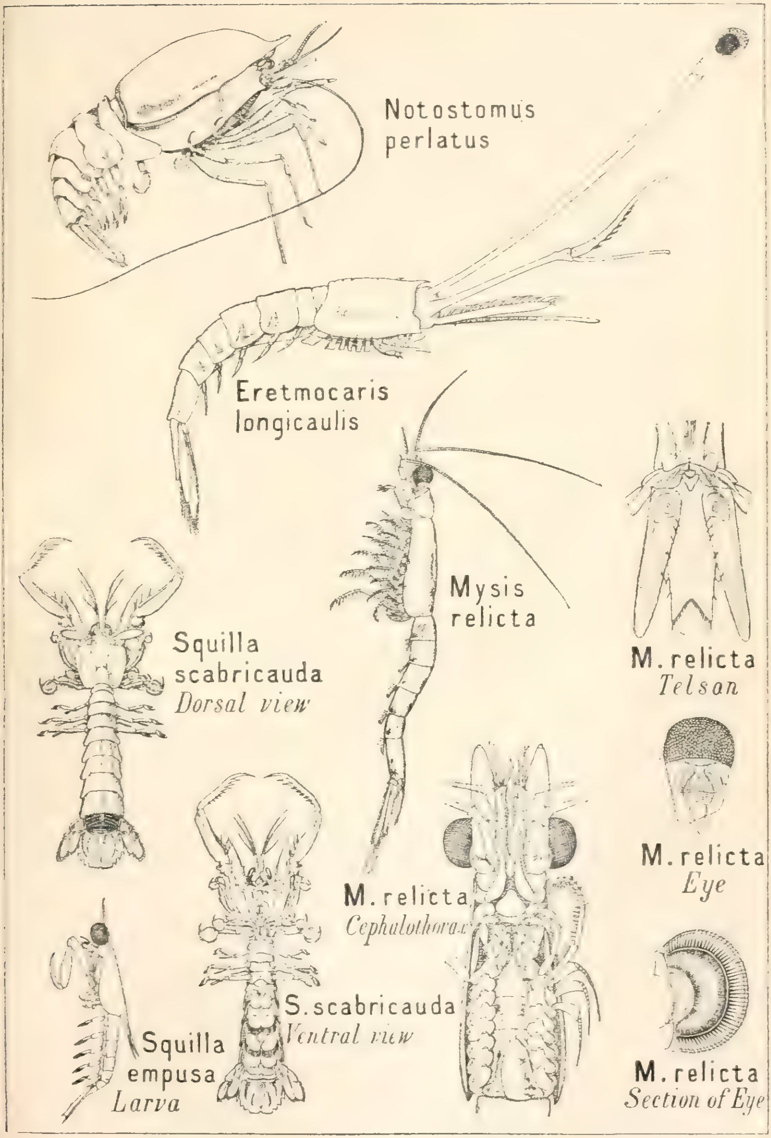


FIG. 23.—*Mysis relicta*, Lovén, the second maxilla.

round. Norman has obtained it from Lough Neagh in Ireland, and by this discovery provides the genus *Mysis* with at least one representative in the British fauna, after despoiling it of all the rest. Sars, in his 'Histoire des Crustacés d'eau douce de Norvège,' has given a most elaborate description of this species, illustrated by highly finished and most instructive plates, and more recently it has been studied by Hansen with his accustomed acuteness. The accompanying figures in the text are copied from Sars. Others from the same author are given in Plate XIII. on a reduced scale.

Macropsis, 'the long-eyed,' is the only other genus agreeing with *Mysis* in the characters of the pleopods of the male, and it is distinguished from *Mysis* both by the extremely elongate eyes and by the structure of the first antennæ, which, in addition to the two flagella and the setose appendage usual in the males of this family, have the apex of the peduncle armed with yet a fourth process,


Notostomus
perlatus
Eretmocaris
longicaulis
Mysis
relicta
M. relicta
Telson
Squilla
scabricauda
Dorsal view
M. relicta
Eye
M. relicta
Cephalothorax
S. scabricauda
Ventral view
Squilla
empusa
Larva
M. relicta
Section of Eye

thin, narrowly conical, ending in a single long seta. This process is not met with in any other genus. The telson is not incised at the apex. There is only a single species known, *Macropsis Slabberi* (van Beneden), first described by Slabber, as a shrimp with trumpet-like eyes. It belongs to British and most other European coasts. Slabber was not a little struck by its organisation, and van Beneden improves the occasion by observing that in a steam-engine on a railway we admire the marvel of human industry that has contrived its complicated parts, but that, if such a locomotive were comprised in a grain of sand, if we could see several of its kind deploying with precision in a drop of water, we ought to be far more excited to astonishment and admiration.

Heteromysis, of which the type is the American, British, and Norwegian species, *Heteromysis formosa*, S. I. Smith, is distinguished from almost all other Mysidæ by having the pleopods rudimentary in the male as well as the female, and also by having the third maxillipeds much stronger than the rest of the legs and ending in a sort of subchelate finger, which induced Sars to call the genus *Chiromysis*, 'the Mysis with a hand,' before he knew that it had been otherwise named by Professor Smith. The telson is incised.

Mysidella is said to stand nearer to *Heteromysis* than to any other genus, but with the first instead of the third maxillipeds strongly built and peculiar. It has the body short and stout, the scale of the second antennæ small, obtusely lanceolate, and fringed with hairs on both margins. The upper lip is obtuse in front, and deeply incised behind; the mandibles have a large cutting plate which is quite simple, without any teeth. The legs are small and weak, the genital appendages of the male being very elongate. The pleopods in the male have the same rudimentary structure as in the female. The telson is short, not deeply incised, and finely aculeate on the hinder portion of each lateral margin. It includes the two Norwegian species, *typica* and *typhlops*, of Sars.

Mysidopsis has the scale of the second antennæ fringed

with hairs on both edges. The molar tubercle, which in *Mysis* is large, has here become obsolete. The pleopods in the male are all natatory. The telson is truncate except in one species. The type species, *Mysidopsis didelphys* (Norman), is British, as are also *Mysidopsis gibbosa*, Sars, and *Mysidopsis angusta*, Sars. All three are also Norwegian, and the last is unique in having no spines or teeth or setæ within the cleft of the telson. *Mysidopsis hibernica*, Norman, 1892, has only been taken at Valentia in Ireland.

Mysideis insignis, Sars, agrees with the preceding genus in having the pleopods of the male natatory, but differs in the mouth-organs, and in the very short incision of the telson it has two long plumose setæ.

Leptomysis agrees with the two preceding genera as to the male pleopods, but agrees nearly with *Mysis* in the mouth-organs; the scale of the second antennæ is divided into two distinct segments, which are setose on both margins. The telson is tongue-shaped, with numerous spines about the apex, which is not incised. Two of the species, *Leptomysis lingvura*, Sars, and *Leptomysis gracilis*, Sars, are British. Norman supposes *Cynthia Flemingii*, Goodsir, to be a synonym of the former.

Hemimysis abyssicŏla, Sars, is not far remote from *Mysis*, but among other differences has the fifth pleopods in the male well developed as swimming-organs. As a deep-water form it is distinct from most of the species of *Mysis*, which are littoral or sublittoral as a rule.

Stilomysis grandis (Goës), formerly included in *Mysideis*, has the first, second, and fifth pleopods in the male similar to those of the female, but the third and fourth pairs with a stiliform outer branch.

Pseudomysis abyssi, Sars, has the eyes quite rudimentary, without either pigment or visual elements. The scale of the second antennæ is fringed with setæ on both margins. The mouth-organs are like those of *Mysideis*. The legs are rather feeble, the sixth joint being much subdivided, and the exopods unusually long. The auditory apparatus in the inner branch of the uropods is rudimentary. The telson is exceedingly short, lamelliform, and

almost quadrate, deeply incised. This, the single representative of the genus, was obtained from depths beyond eleven and twelve hundred fathoms in the Northern Ocean.

Anchialus typicus, Kröyer, belongs to a genus in which the scale of the second antennæ is remarkably small, the pleopods in the male well developed, but partly obsolete in the female. The telson is large and incised at the apex. The female has on the first segment of the pleon small horizontally projecting side-plates. Of the small but robust and very broad species *Anchialus agilis*, Sars, a specimen is recorded from Plymouth. *Anchialus pusillus*, Sars, from the Pacific, was at first assigned to Dana's genus *Promysis*. The specimens described have greatly developed marsupial pouches, from which it is inferred that they were full-grown, and yet in length they barely attain one-eighth of an inch, about as small a size as an adult shrimp could well be expected to content itself with.

Erythrops, 'the red-eyed,' was a name given by Sars in 1869 to part of the genus *Nematŏpus*, a preoccupied name which he had used in 1863. As the earlier name implies, the legs are very slender, nearly filiform. They terminate in a well-formed nail. The telson is very short, scarcely longer than broad, apically broadly truncate. Of the three species here mentioned, all are British. *Erythrops serratus*, Sars, is distinguished by Norman 'from all other British Mysidea by the serrations of the outer margin of the antennal scale.' He says that 'the very large reniform eyes are of a lovely and brilliant ruby red.' *Erythrops erythrophthalmus* (Goës) refers to this colouring of the eyes both in the specific and generic names. Sars changed the name of Goës' species, which had been originally assigned to *Mysis*, into *Nematopus Goësii*, on the very ground that the redness of the eyes was common to all the species of the new genus, but the earlier name should be retained notwithstanding. *Erythrops pygmæus*, Sars, has been identified by Sars with his own earlier *Nematopus elegans*, so that the name must be *Erythrops elegans*. *Parerythrops obesus*, Sars, was at first doubtfully included in the genus *Nematopus*, with the other more slender species.

Euchætomera, with two species *typica* and *tenuis* from the Pacific, agrees with *Erythrops* in the form of the very short, lamellar, unincised telson. The scale of the second antennæ is smooth on the outer margin. The legs are very slender. Some of the joints of the legs, the pleopods in both sexes, and the uropods, are fringed with long setæ, from which circumstance it may be supposed that the generic name is derived, meaning 'with the parts beautifully hairy.' Professor Chun comments on the astonishing length of the upper antennæ in the type species, which he regards as a transitional form between *Mysis* and his own *Arachnomysis Leuckartii*.

Siriella, Dana, was originally named *Cynthia*, by Vaughan Thompson, but the name was preoccupied, and Dana's *Siriella* takes precedence of White's *Cynthilia*. The genus is characterised chiefly by the structure of the legs, 'which are more decidedly unguiculate than in any other known genus of Mysidans,' and have the sixth joint entire or subdivided into two articulations only; also by the pleopods of the male, which are natatory, and have the 'basal lobe of inner branch usually transformed into two gill-like, more or less spirally twisted stems.' The outer branch of the uropods is broader than the inner, and has an imperfect articulation at the apex. The telson is elongate, densely spinose at the edges, with the apex not incised. The species are numerous, and many of them are met with at the surface of the sea, far from the coast. The British species, as far as at present known, are: 1. *Siriella norvegica*, Sars, in which the third joint of the first antennæ has three setæ on the inner margin, and between the spines at the angles of the telson three spinules, of which the central is the largest. 2. *Siriella Clausii*, Sars, of which Norman gives the distinguishing characters as 'the single seta on inner margin of last joint of peduncle of antennules, the slender legs and claws, and three equal-sized spinules between the ultimate spines of the telson.' 3. *Siriella jaltensis*, Czerniavsky, identified by Norman with the later *Siriella crassipes*, Sars, in which the form is somewhat more robust and the legs much stronger than in the

preceding species, while the telson terminates 'in a small spinule flanked on each side by the usual setæ, and a more minute spinule between the ultimate pair of spines.' 4. *Siriella Brooki*, Norman, which seems to be intermediate between *Siriella Clausii* and *Siriella jaltensis*, having the single antennular seta of the former, and the apex of the telson armed as in the latter, the legs also being of intermediate thickness. 5. *Siriella armata* (Milne-Edwards), which is distinguished by an elongate rostrum reaching the end of the second joint of the first antennæ, and by the telson 'terminating usually in four equal-sized spinules and two setæ between the ultimate spines.' In Norman's opinion both *Mysis Griffithsiæ*, Bell, and *Mysis productus* (Gosse) may be synonyms either of this or of the next species. *Pseudosiriella*, Claus, was instituted to receive the species *Mysis frontalis*, Milne-Edwards, which Sars had previously transferred to *Siriella*. It has a well-developed rostrum like *Siriella armata*, but the appendages, to which a branchial function has been attributed, on the pleopods of the male, are here simple instead of being coiled. According to Canon Norman, *Pseudosiriella frontalis* belongs to the British as well as the Mediterranean Fauna.

Gastrosaccus, Norman, is distinguished by the laterally compressed carapace, and in the female by the great development of the side-plates of the first pleon-segment which appear to assist the marsupium in the retention of the eggs. The marsupial plates are two pairs, the first pair being very small and sending a strap-shaped setiferous process into the cavity of the pouch. The first pleopods in the female are very large, the rest very small. All the pleopods of the male are biramous and at least in part natatory. The telson is apically incised. *Gastrosaccus sanctus* (van Beneden) is found in the Mediterranean, on the Belgian and French coasts, and at Jersey. *Gastrosaccus spinifer* (Goës) is found both in the Baltic and on the coasts of Great Britain, and is distinguished from the preceding species by the dentately fringed hind margin of the carapace and by a well-developed dorsal spine on the fifth pleon-segment.

Haplostylus, Kossmann, was established to receive the Mediterranean species, *Gastrosaccus Normani*, Sars, which is also found off the coast of Ireland, and a Red Sea species, *Haplostylus erythraeus*, Kossmann, the generic distinction consisting in the absence of the forward directed lobes on the concave hinder rim of the carapace, which are found in the species of *Gastrosaccus* above mentioned, and also in the reduction to a rudiment of the inner natatory branch of the third pleopods of the male.

It will be seen from the foregoing notes that fifteen genera of this family are represented in the Fauna of Great Britain, and it is quite possible, and even probable, that extended research may show that others of the genera and species occur round the very varied coasts of the British Isles, which in their southern parts, especially if the Channel Islands are included, are in rather marked contrast to the region of the Orkneys and the Shetland Isles, among which Norwegian and Arctic forms may readily present themselves. It will be understood that, although an endeavour has been made to mention all the valid, or at least all the commonly accepted, genera of the Schizopoda, there are very numerous species belonging to those genera of which it has been impossible to take notice.

CHAPTER XIX

SUB-ORDER IV.—STOMATOPODA

THE carapace is feebly developed, leaving uncovered at least the last three segments of the trunk; the pleon is powerful, and, like the carapace, usually depressed, not laterally compressed. The eyes are stalked. The second antennæ have a scale. The mandibles have a small or rudimentary 'palp.' The three pairs of maxillipeds and the two following pairs of appendages are variously modified as six-jointed prehensile limbs, with epipods, but without exopods; the second maxillipeds being predominant in size and importance. The three following pairs of legs are feebly developed, with exopods, but without epipods. The first five pairs of pleopods generally carry each a pair of large ramified branchiæ arising from the outer branch. There is a special apparatus on the inner branch of the first pleopods in the male. The caudal fan is powerful. The heart is elongate, with several pairs of lateral venous fissures. The ovaries and testes lie chiefly in the pleon, and have their two halves united by a median piece. There are no spermatophores. The spermatozoa are simple, rounded cells. The young are hatched not as Nauplii, but in a more advanced stage. The carapace of the young is largely expanded.

The above definition is chiefly taken from that given by Dr. J. E. V. Boas for the 'Order Squillacea,' in his highly esteemed 'Studies on the Relationships of the Malacostraca.' It is in this sub-order that the typical number of twenty-one segments has been distinguished in a single animal. Usually the first antennæ have three flagella, one of the two principal ones sending off a branch from

near its base. The ocular and antennal segments are more or less movable. and not covered by the carapace. The two pairs of maxillæ are rather simply constructed. The first of the two series of legs are closely applied to the mouth, and from this circumstance the sub-order has received its appellation of 'mouth-footed.' According to Professor W. K. Brooks, in his Report on the *Challenger* Stomatopoda, there are about sixty species known of adults, and an equal or greater number of larvæ, from the tropical, sub-tropical, and temperate waters of the Atlantic, Pacific, and Indian Oceans. Some of the species range over the whole of this area, while others are known from only a single restricted locality, almost a fourth of the species having been described from single specimens. They are usually found in very shallow water, only one or two species being reported from depths like a hundred and twenty fathoms. 'The wide distribution of many of the species is undoubtedly due to the great length of their larval life, during which they swim at the surface, and are swept to great distances by the oceanic currents.' On the other hand, the adults are extremely active in their movements and retiring in their habits, most of them being burrowing animals, from which it results that they may long remain undiscovered even in localities where they are abundant. Some, like *Squilla empusa*, which hunt far from their burrows, are often caught in nets and trawls, but 'others, such as *Lysiosquilla excavatrix*, are the Myrmeleons of the ocean, lying in wait for their prey, covered with sand, with only the tips of their eyes exposed, at the mouths of their very deep burrows, to the bottoms of which they dart at the least alarm.' At a station where they were extremely numerous, Professor Brooks could scarcely capture one, till he devised the insidious plan of holding bait in one hand and a trowel in the other at the mouth of the burrow, and even so with his best speed the trowel often cut in two the retreating quarry.

Family Squillidæ.

As this is now the only family, it has the characters of the sub-order. The family Erichthidæ, which was formerly its companion, has been shown to consist entirely of larval forms. In the Squillidæ Brooks accepts 'seven genera, *Protosquilla*, *Gonodactylus*, *Pseudosquilla*, *Coronida*, *Lysiosquilla* (including *Coronis*), and *Squilla* (including *Chloridella*).' As only six genera are named, it is doubtful whether seven is a misprint, or intended tacitly to include *Leptosquilla*, Miers, which had been previously spoken of as very slightly known. Professor Brooks lays great stress on the marginal spines of the telson, of which there are usually six, arranged in three pairs. These he designates as the primary marginal spines, and distinguishes the two nearest the middle line as the submedians, the two nearest the anterior edge, which are usually the farthest from the middle line, as the laterals, and the one between the lateral and the submedian on each side as the intermediate. 'Between these six primary marginal spines there are others which are equally large and prominent in the young larvæ, but minute or absent in the adults;' these he calls the secondary marginal spines. The characters of the great second maxillipeds, spoken of as the raptorial claws, and the connection of the sixth segment of the pleon with the telson, are also of great importance in distinguishing the genera. Another structure, which 'often presents characteristics of specific value, and differs conspicuously in the different genera,' is that found upon the inner branch of the first pleopods in the male, 'a complicated grasping organ which probably serves for seizing the female, like the grasping forceps of many of the lower Crustacea and some few of the Malacostraca.'

Squilla, Fabricius, 1793, agrees with all the other genera, except *Protosquilla* (and perhaps *Coronida*), in having the sixth pleon-segment separated from the telson by a movable joint. The terminal joint of the second maxillipeds is without a basal enlargement, but with a series of spines, usually not more than six in number, on

its inner edge. The pleon is depressed and wide; the inner spine of the ventral prolongation from the peduncle of the uropod is longer than the outer; the telson is usually longer than wide, and it has more than four secondary spines between the intermediate and submedian marginals.

There are numerous species in this genus. *Squilla mantis* received the name which it still bears from the French naturalist Rondelet in the sixteenth century. That author warns his readers that they will not find any account of this species in the older writers, such as Aristotle and Pliny, Athenæus and Oppian. He chose the specific name because of the likeness which this long-armed marine animal shows to the Mantis insect, and he explains that the Mantis or 'soothsayer,' also known in the south of France as the Preguediou or praying insect, derived the latter name from its emaciated devotee-like figure, and the former from the childish superstition that if asked the road to Rome or to St. James of Compostella, it would indicate it by holding out one or other of its arms. He takes the opportunity of observing that his contemporary Bellon has given a very bad drawing of this species, leaving out much that should have been put in, and putting in much that ought to have been left out. Yet Rondelet himself appears to bestow upon the pleon several more segments than it is by nature endowed with. This species is occasionally found in British waters, but is much more common in the Mediterranean, where it is used as an article of food. It attains a length of seven inches. The membranaceous carapace has a longitudinal central ridge, and on either side there are strong grooves. It narrows forwards, and in a specimen six and a half inches long, the carapace, including the rostrum or movable frontal plate, is about an inch and three quarters long. The eyes have a peculiar hammer-like appearance, being very wide on narrow stalks. The second maxillipeds have the terminal joint armed with in all six long teeth which can close against pits in the margin of the strong preceding joint. This joint itself has a minutely denticulated border alongside of the pits, and also three movable spines near its base. The outer margin

may be clasped back into a deep groove in the outer margin of the joint next but one preceding it. The three following pairs of limbs are very much smaller, the terminal joint finger-like and clasping against the much dilated preceding joint. The next three pairs of legs are slender and four-jointed, with a slender exopod on the second joint. The very large pleon has the centre of the back smooth, but four carinæ on each side, which commence indeed on the last three segments of the trunk, but are not continued on to the telson. This latter has a powerful central carina ending in a tooth a little before the apex is reached. Between the strong submedian spines there are eight minute denticles, and between each submedian and its corresponding intermediate there are nine denticles. Another Mediterranean species, also occasionally found on the English coast, *Squilla Desmarestii*, Risso, is distinguished by having only five teeth on the claws, and fewer longitudinal keels on the first five segments of the pleon.

In the United States *Squilla empūsa*, Say, is often thrown on the beaches by the waves, and it probably burrows near low-water mark or not far out beyond it. Large specimens, Professor Smith says, 'are eight or ten inches long and about two broad.' After describing the second maxillipeds as much in accordance with those of *Squilla mantis*, he remarks:—'By means of this singular organ they can hold their prey securely, and can give a severe wound to the human hand, if handled incautiously. It also uses the stout caudal appendages, which are armed with spines, very effectively. The body is usually pale green or yellowish green, each segment bordered posteriorly with darker green and edged with bright yellow; the tail is tinged with rose and mottled with yellow and blackish; the outer caudal lamellæ have the base and spines white, the last joint yellow, margined with black; the inner ones are black, pale at base; the eyes are bright emerald-green; the inner antennæ are dark, with a yellow band at the base of each joint; and the flagellum is annulated with black and white.' *Squilla armata*, Milne-Edwards, is another species very little remote from *Squilla mantis*, but among other differences the

claws have seven teeth. This species, originally described from Chili, has been found also in New Zealand, a locality to which *Squilla nepa*, Latreille, has likewise been assigned, but of its occurrence there Mr. Charles Chilton thinks there is much doubt. The genus *Chlorida*, Eydoux and Souleyet, 1841, had a preoccupied name, which was changed into *Chloridella* by Miers in 1880, but Professor Brooks thinks it unnecessary to separate it from *Squilla*.

Squilla scabricauda, Lamarck, is from the Antilles. Desmarest's figures of it (see Plate XIII.) are designed to show the series of limbs as distinctly as possible, the small first maxillipeds being pulled back behind the large second pair, which would otherwise obscure them. The species should probably be referred to *Lysiosquilla*, the genus next mentioned.

Lysiosquilla, Latreille, 1825, has the terminal joint of the second maxillipeds not enlarged at the base, and armed with more than six spines. The pleon is depressed, loosely articulated, and wide. The outer spine of the ventral prolongation from the peduncle of the uropod is usually longer than the inner. Between the submedian and intermediate marginal spines of the telson there are no more than four secondary spines, and there is often only one spine. The species *Coronis scolopendra*, Latreille, has been incorporated in this genus, the generic name *Coronis*, though earlier, having been preoccupied. *Lysiosquilla maculata* (Fabricius) has nine spines on the claw of the adult male, and seven or eight on that of the female, those of the female moreover tending to weaker development, although, it is said, such 'secondary structural differences between the sexes are extremely rare among the Stomatopoda.' *Lysiosquilla spinosa* (Wood Mason) is found at various parts of New Zealand, and is there the only species of the genus, according to Mr. Chilton, who has recently re-described it, with special reference to the apparatus on the first pleopods of the male. *Lysiosquilla excavatrix*, Brooks, has on its claw fourteen or fifteen short curved pointed teeth, besides the long terminal one. The whole dorsal surface, rostrum and telson included, is smooth and

highly polished, and without carinæ or spines. The female is much larger than the male, of an opaque olive brown, almost black colour, while the male is of a transparent grey. Professor Brooks gives an interesting account of its habits:—

'It is found in the sand of the ocean beach just below low-tide mark, where it is exposed to the full force of the ocean swell, and it inhabits a very deep cylindrical burrow which is nearly vertical and goes down for several feet. While watching for its prey the animal stations itself at the mouth of the burrow, which is arched over with sand, so that only the tips of the eyes are exposed. The food consists of small Crustacea, fishes, and other small animals, and when one approaches within reach the *Coronis* [Lysiosquilla] darts out of the burrow, knocking away the loose sand, and seizing it in its raptorial claw it darts backwards with it and retreats to the bottom of the burrow. When hungry it often captures prey at a distance of six or eight inches, but, as a rule, it waits until it is near enough to be caught without leaving the opening. The food which is captured is usually stored away at the bottom of the burrow, and the animal returns to the mouth and resumes its watch. In excavating its burrow the animal begins by stretching its body out on the sand, which is then swept away from under it by the action of the abdominal appendages, until all of the body except the eyes and telson are buried. It then forces its head into the loose sand which has been stirred up by the action of the abdominal appendages, and dragging its body down it quickly becomes buried vertically, head downwards, and it continues to burrow until it reaches the hard undisturbed sand, when it bends upon itself, and passing the head up on the ventral side of the swimmerets it reverses its position and works upwards to the surface, hardening and compressing the sand by the pressure of the dorsal surface. After the upper end of the burrow is thus rendered firm and circular, it again doubles upon itself, and going to the bottom gathers an armful of sand, which is clasped against the ventral surface of the body between the large

second maxillipeds, where it is held in place by the flat oval chelæ which are tightly clasped over it. At the opening it stretches out as far as it can reach without leaving the burrow, and dropping the armful of sand it smoothes it down until it is level with the surrounding surface. This process is then repeated until the burrow reaches a great depth, for I have dug for three or four feet without reaching the end, and all the specimens which I kept in confinement burrowed to the bottom of the aquarium. When the burrow is finished the animal spends most of its time near the top, and as the semi-circular exopodites of the abdominal appendages complete the outline formed by the convex dorsal surface, it completely fills the circular tube, into which the constantly vibrating scoop-like abdominal appendages carry a continuous current of water, which escapes through the loose sand.'

Pseudosquilla, Dana, 1852, has a name originally coined but not published by Guérin.

In this genus the terminal joint of the second maxillipeds is without basal enlargement and with few marginal spines or none; the pleon is smooth, convex, and narrow; the terminal joint of the first pleopods of the male imperfectly divided by a marginal notch into an inner and outer lobe; the telson has the submedian spines long and tipped with movable spinules, and usually it has a single secondary spinule, but sometimes two, three, or four such spinules between the submedians and intermediates. *Pseudosquilla ciliata*, Miers, a species found alike at Honolulu and in the West Indies, is of a bright cherry red colour.

Gonodactylus, Latreille, 1825, has the terminal joint of the second maxillipeds enlarged at the base, and without marginal spines; the pleon narrow, convex, thick; the primary marginal spines of the telson very large, with one or two secondary spines between the submedians and intermediates.

Gonodactylus falcatus (Forskål), according to Kossmann, must supersede the better known name *Gonodac-*

tylus chiragra (Fabricius). The species appears to have a vast range, and its colour is said to be exceedingly variable.

Coronida, Brooks, 1886, has the carapace flat and nearly rectangular. The rostrum ends in a small median spine; the scale of the second antennæ is very small; the terminal joint of the second maxillipeds is dilated at the base, and armed with spines on the inner margin. The pleon is depressed; its hind segments and the telson are thickly set with small spines. The uropods are very small. The name of the genus is compounded from the names of the rejected genera *Coronis* and *Chlorida* (or *Chloridella*), to indicate Professor Brooks's view that like them it contains somewhat primitive species. These are *Coronida Bradyi* (A. Milne-Edwards) and *Coronida trachūrus* (Miers), both of which were originally assigned to *Gonodactylus*. The professor seems inclined to suspect that the sixth pleon-segment may prove to be fused with the telson, but the type-specimens of Miers's species in the British Museum show that at least in *Coronida trachurus* the telson is quite distinct from the preceding segment and freely movable upon it.

Protosquilla, Brooks, 1886, has the rostrum furnished with long acute median and anterolateral spines; the eyes and the scale of the second antennæ small; the terminal joint of the second maxillipeds dilated at the base, without marginal spines; the pleon convex, its sixth segment more or less completely fused with the telson; the uropods small. Professor Brooks considers the name of this genus 'the more appropriate inasmuch as all the other Stomatopoda present evidences of divergent descent from a common stem form, which, like the living representatives of the genus *Protosquilla*, was characterised by the small size of its eyes, antennary scales, and uropods.' Seven species are included in the genus, among which *Protosquilla elongata*, Brooks, with a carinate and bilobed but otherwise simply constructed telson, presents a rather striking contrast to *Protosquilla Guerinii* (White), in which the dorsal surface of the telson carries twenty-two

long spines symmetrically arranged, while the preceding segment, which in the other species has some rather inconspicuous carinæ, here has about fifty-six long cylindrical spines, 'each of which ends in a blunt rounded tip with a perforation from which a soft tubular fleshy process protrudes.'

Leptosquilla, Miers, 1880, is defined as having the 'ophthalmic segment greatly elongated; rostrum not reaching beyond half the length of this segment,' and to it is assigned the single species *Leptosquilla Schmeltzii* (A. Milne-Edwards), from the Samoa Islands.

For a history of the development of the Stomatopoda the foundation was laid by Dr. Claus in 1871. Many additions have been made and much precision given to the knowledge of this subject by the researches of Professor Brooks. The transparent pelagic larvæ are frequently captured, and in consequence of their glass-like clearness the individual organisms can be easily studied, but there are special difficulties connected with tracing the series of changes which they pass through between the egg and the adult condition. Unlike most Malacostraca, the Squillidæ do not carry their eggs about with them, but deposit them in their deep burrows, there to be aerated by the currents of water which the pleopods of the parent maintain. Hence the hatching of eggs in an aquarium has not yet been brought about. The older larvæ are hardy, but seldom found near the shore. The younger larvæ can be found near the shore, but seldom moult in confinement. The life-history has, therefore, to be traced by a comparison of numerous forms collected from the open sea, and here there is a twofold risk, of uniting the larvæ of quite distinct animals as stages in the life-history of a single species, and of disuniting the larval stages of a single species as though they belonged to distinct species or even distinct genera. In this labyrinth the explorer has to be guided in part by general resemblances, but more especially by comparative measurements. Professor Brooks, having obtained a number of specimens which by general resemblance seemed to make

a good series, proceeded to tabulate the measurements in millimetres. He was disappointed, however, not to find any such conformity to a general law as he had expected. It then occurred to him that in the larva change of form and increase of size are going on together, and that one organ might be diminishing relatively to another organ while it was increasing relatively to itself in a former stage. He therefore reduced his measurements to a common standard, expressing them in thousandth parts of the total length of the larva at each stage, and this usually enabled him to decide whether a given larva did or did not belong to a particular series. Apart from this, in one instance which he mentions his comparative measurements obtained a triumph parallel in its way to that of Kepler when he found that the positions of the planets conformed to a numerical law. Having a series of larvæ apparently of the so-called *Coronis* (*Erichthus*) *minutus*, of which the youngest measured 4·16 millimetres, the second 5·29 mm., the third 6·49 mm., and the fourth 10·21 mm., he observed that if 4·16 is multiplied by five-fourths, and the result by five-fourths, and so on, the resulting series of numbers is

(1) 4·16, (2) 5·20, (3) 6·50, (4) 8·13, (5) 10·16,

which corresponds as exactly as need be with the series of larvæ, allowing for the absence of the fourth stage. It is highly improbable that larvæ bearing a general resemblance to one another would have this curious numerical relationship unless they also had a very near relationship by blood likewise. Professor Brooks considers that 'the free prolonged larval life has brought about modifications which have no reference to the life of the adult, so that the larvæ differ among themselves more than the adults do.' By reason of their small size and great transparency some of these larval forms are very suitable and interesting objects for the microscope.

The following list will show the names attached to the young forms of the different genera :—

Alima is the larva of . . .	*Squilla*.
Alimerichthus	*Squilla* (*Chloridella* group).
Lysioerichthus (short-spined)	*Lysiosquilla*.
Lysioerichthus (long-spined) .	*Lysiosquilla* (*Coronis* group).
Erichthalima	*Coronida*.
Pseuderichthus	*Pseudosquilla*.
Gonerichthus	*Gonodactylus*.
An unknown form	*Protosquilla*.

In support of this affiliation Brooks says, 'Faxon has reared a *Squilla empusa* from an *Alima* larva. The *Challenger* collections show that the larva of *Lysiosquilla maculata* is one of the short-spined *Lysioerichthi*; I have reared *Lysiosquilla* (*Coronis*) *excavatrix*, one of the more primitive *Lysiosquillæ*, from a long-spined *Lysioerichthus*. Claus has figured a series which shows beyond question that at least one species of *Pseuderichthus* becomes a *Pseudosquilla*, and the *Challenger* collections furnish equally good proof that the *Chiragra* group of *Gonodactyli* come from *Gonerichthus* larvæ, and I therefore believe that we may very safely assume that all the *Lysioerichthus* larvæ are young *Lysiosquillæ*, all the *Alima* larvæ young *Squillæ*, *Alimerichthus* one of the lower *Squillæ* or *Chloridellæ*, all the *Gonerichthi* young *Gonodactyli*, *Erichthalima* very probably a young *Coronida*, and all the *Pseuderichthi* very probably young *Pseudosquillæ*.'

CHAPTER XX

ORDER II.—EDRIOPHTHALMA

In this order there is generally a pair of compound eyes, which are sessile; they may be prominent, but are never movably stalked; they may be absent, or placed so closely together as to form apparently, but not really, a single eye. On the other hand, the visual elements may be variously distributed, so as to form compound eyes from one to four in number, or simple eyes that are not limited to four. The last seven segments of the trunk are generally not, and the last four are never, included in the carapace.

Three sub-orders are comprised in this order—the Cumacea, Isopoda, and Amphipoda.

Sub-order 1.—*Cumacea.*

As with the Squillidæ, so with the Cumacea, nothing is to be found about them in the writers of antiquity, but about the latter sub-order even the sixteenth century knew no more than its predecessors. Not a single species was recorded before the year 1779, and for sixty years after that date science contented itself with half a dozen species, some of which were so obscurely or imperfectly described that they are still doubtful. Since 1841, by the exertions of a few naturalists, chiefly Scandinavian and Anglo-Saxon, the characters of the group have been investigated with great thoroughness. The distribution extends to all oceans, and from tide-marks down to very great depths. By rapidly repeated discoveries the known forms have now become numerous, and are classified in

eight families, together containing twenty-five or twenty-six well-defined genera, and about a hundred and eighteen satisfactorily determined species. In certain localities the extreme abundance of some of these supplies a welcome food to shoals of herring. In size and number of individuals the Arctic species appear to excel all others. It is probable that many forms still remain to be discovered, since up to 1876 a single species obscurely described from the Black Sea was the sole representative of the sub-order in the area of the Mediterranean, where in the winter of 1876 Professor Sars found no less than twenty-three species, of which fourteen were new to science. Before 1859 none were known from the waters of the Clyde, and in these Mr. David Robertson, of Cumbrae, has since found fifteen species.

Among the curiosities of scientific literature are the disputes which have occurred actually within the last fifty years, as to whether the Cumacea did or did not possess organs of vision, and as to whether they were or were not merely larval forms. The well-known and diligent observer, Colonel Montagu, at the beginning of the century found in South Devon a species which in fact possesses sight, but not unnaturally Montagu did not attempt to discover the creature's eye, because he was under the impression, though an erroneous one, that his solitary specimen had lost its head. Kröyer, many years later, happening to meet with various species which are in truth blind, formed the opinion that all the species were so, and that eyes had been attributed to some of them under an illusion. Harry Goodsir, a Scotch naturalist, in 1843 published the remarkable statement that the eyes are 'pedunculated but sessile.' He lost his life not long afterwards in Franklin's Arctic expedition, and left his opinion to be for many years doubted, denied, or supported, without its being in his power to explain that what he obviously intended to print was that the eyes were *not* pedunculated but sessile. It is probable that Kröyer was completely mystified by the misprint. 'Goodsir,' he says, 'thought that eyes must be found in the

creatures, and he therefore found them.' Some years earlier Milne-Edwards had indeed described a species as having two eyes, which almost certainly has but one; so easily are even the ablest naturalists misled into taking for granted that what is customary will prevail. A very few of the Cumacea have two eyes. The majority have a single median eye, but occasionally the elements of this compound organ are so arranged as to have the appearance of several distinctly separated ocelli.

The Cumacea are said to leave the egg as maggot-shaped Nauplii. From the maternal pouch they issue almost in the adult form, only being as yet without the last pair of trunk-legs or peræopods, a deficiency which in two species, *Campylaspis nodulosa*, Sars, and *Leptostylis manca*, Sars, is perhaps persistent. The notion that these creatures, which are in truth born almost fully fledged, were only larval forms, was early disproved by Goodsir and Kröyer, but was nevertheless still upheld for several years by three of the most distinguished naturalists of the century.

In no group of the Malacostraca is the general form more characteristic than here. This is principally due to two unvarying features, the narrowness of the pleon and the prominence of an elongate pair of uropods at its extremity. A distinct telson may or may not be present; of the six preceding segments none is ever wanting, and of these the fifth, without any trustworthy exception, is the longest. The front part of the body is always more bulky than the pleon, and sometimes enormously so. The integument is often stoutly crustaceous, more ready to break than to bend.

Normally there are five segments of the trunk distinct behind the carapace, carrying respectively the five pairs of peræopods. Occasionally, however, the first of these five segments is absent or rudimentary, and in one genus the third and fourth segments are coalesced. Sometimes the carapace overarches one or more of the free segments. More or less completely sheltered beneath the carapace lie all the organs from the eyes to the third maxillipeds. There

are no chelate limbs to which the terms chelipeds or gnathopods would be applicable.

The adult males are very strikingly distinguished from the females in more than one particular. Thus, the females have the lower antennæ of insignificant size, while in the males they are developed to a great length, though they are not always very apparent, as they are often securely tucked away along the sides of the body, an arrangement which seems to imply that they are of exceptional value, and possibly also only of exceptional use. Again, the females never have pleopods, while the males have them, except in a single genus, throughout six of the eight families. Moreover, in all the families but one the males have well-developed exopods or swimming-branches attached to all the first four pairs of peræopods, whereas the females never have them on more than three pairs, and sometimes only on one or two. These disparities are connected with the habits of the animals. For at night-time it is found that the surface-net in suitable localities will secure the males of certain species in abundance, not intermingled with any females. The latter sex, on the other hand, is generally found to preponderate when their settlements in the sand and mud are invaded. The females are evidently of a less roving disposition than their mates. Yet their movements are not destitute of considerable liveliness and energy. To compensate them, too, for their inferior swimming apparatus, they very commonly have the carapace ornamented with various spines and tubercles, which may be supposed to form a sort of defensive armour against some of their foes. The more active males, on the contrary, seem to find their advantage in having the carapace smooth. To the student this last distinction is not a little embarrassing, for much smaller differences than those which here mark the external appearance of the two sexes have frequently been allowed specific value.

The upper antennæ of the Cumacea are always small, with two diminutive flagella, of which one is sometimes evanescent. The upper lip is a single lobe between the bases of the lower antennæ. The lower lip forms two

lobes with finely ciliated edges. Between the lips the hard and strong mandibles make their dentate cutting edges meet. They have no 'palp.' The left mandible, and rarely also the right, has a secondary plate on the inner side. The molar tubercle is generally a long and strong process at right angles to the body of the mandible, with a denticulate crown; but in one family, the Campylaspidæ, the process is thin and stiliform. Between the cutting edge and the molar there is usually a row of spines. It is, however, distinctive of one family, the Leuconidæ, that this spine-row is absent, being represented only by a couple of setæ. The first maxillæ may be roughly described as consisting of an inner and outer plate, each tipped with spines, and of a backward directed 'palp.' The inner plate is an expansion of the first joint, and the outer plate an expansion of the third, the small second joint between them being very little conspicuous. Close to the base of the outer plate on its outer side is placed the 'palp,' which may be the fourth joint of the endopod turned back to serve a particular purpose. It is very movably articulated, and ends in one or two long setæ. Its function is reasonably supposed to be that of clearing the branchial sacs from any obstructive particles which might be brought in along with the water introduced by the action of the breathing apparatus. In the genus *Paralamprops*, however, this service must be dispensed with, for there the 'palp' does not exist.

The second maxillæ are analysed by Hansen into four joints, of which the second is very large, having a row of setæ on the inner margin and a small terminal plate tipped with setæ. The third and fourth joints have also each a similar small terminal plate, and to the outer rim of the third joint is attached a thin plate with curved margin, which is explained to be morphologically a weaker development of the fan as it occurs in the Mysidæ.

Upon the next pair of appendages, the first maxillipeds, the interest of the Cumacean group is above all concentrated, for these present features that are unique among the Crustacea. The endopod or limb-like portion of the

maxilliped is not of exceptional structure. The second joint is large, usually with a terminal plate having coupling hooks on its inner margin. The seventh joint is wanting, and in the genus *Campylaspis* the fifth and sixth also, the fourth joint being rudimentary and terminal, and the second joint in this case not carrying an apical plate. All the known forms, however, agree in having in connection with the first maxillipeds a remarkable respiratory apparatus. The hinder part of this, being certainly attached to the first joint, no doubt represents the epipod, while the front part, though coalesced with the hinder part, may in reality be derived from the second joint, and in that case it will, as Sars supposes, represent the exopod. This latter opinion is sometimes contested, but, however that may be, it is to Sars that belongs the honour of having first clearly made known the manner of action of these structures, as well as of having beautifully delineated the intricate forms which some of them assume. The epipod directed backwards into the branchial cavity finds many parallels, as in the Mysidæ, where likewise its oscillations contribute to maintain a steadily renewed flowing in of water. But in the Cumacea the epipod is usually furnished with branchial sacs, sometimes in large numbers and spirally arranged. To this there is nothing properly parallel in these appendages elsewhere. The anterior or exopodal portion of the apparatus is even more singular. The pair of these plates on the two maxillipeds are sometimes firmly coalesced together, but in any case they meet and form a tube which can be projected in front of the head and again withdrawn. As long as the animal continues the peculiar twisting movements which in life it so frequently exhibits, the branchial apparatus is completely motionless. But when it is in turn quiescent, the transparent end of the tube is shot out under the pseudo-rostral end of the carapace between the bases of the antennæ, while the gill-bearing epipodal plates are set oscillating. When the gill-plates move forward the water is forcibly expelled through the end of the tube. When the plates move back, the slit-like orifice of the tube closes of itself through the elasti-

city of the membrane, and the expelled water is thus prevented from returning. On the other hand, a new supply of water can now enter through the openings at the sides of the maxillæ, and these openings in their turn are then closed by the forward movement of the gill-plates. By this means the gills are kept washed by a continually fresh current of water, of essential service to the health and vital energy of the animal, although it is obvious that the creature when burying itself in the sand can for a time dispense with this mode of aerating its blood. In the Epicaridea, a group of Isopoda, to be mentioned hereafter, the marsupial plates of the first gnathopods (second maxillipeds) have a function similar to that of the epipods just described.

FIG. 24.—*Diastylis stygia*, Sars. First maxilliped, with branchial apparatus, female specimen [Sars].

In the egg bearing females of the Cumacea, the second pair of maxillipeds have at their base a broad fan directed straight backwards within the ventral body wall. This is formed by the two epipods, each represented by a small round plate armed on its free margin with several long setæ.

In the young and the males these plates are rudimentary and without trace of setæ. The inference, therefore, cannot be avoided that they have to do with some maternal duty. 'It will be found,' Professor Sars observes, 'that they constantly have their place in the front part of the marsupium, and with their long setæ work in among the eggs and embryos contained in it. Their function can, therefore, be nothing else than to bring about the rotation or movement of the eggs included in the marsupium, which is very clearly observable in living specimens, and which in the Mysidæ and Isopoda is brought about in a somewhat different way, by a peculiar rhythmical movement of the plates themselves of which the marsupium is composed.'

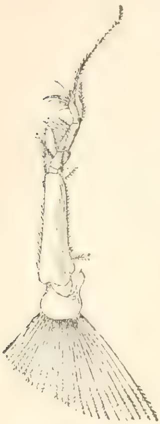


FIG. 25.—*Diastylis Goodsiri* (Bell). Second maxiliped, of female [Hansen].

The third maxillipeds have a well-developed exopod or swimming-branch, the second joint to which it is attached being almost always of very considerable size, and more often than not produced at the outer apex.

Of the five pairs of trunk-legs or peræopods the first is usually much elongated. In almost all cases the second joint in these limbs is the longest. It is only rarely that the terminal joint is of the curved pattern found in the so-called fingers of many Crustacea. The three hinder pairs might, it is said, from the habits of the animals, rather be called digging than walking feet.

The pleopods of the male vary in pattern as well as in number. They are only fully developed in the adult. They usually consist of a two-jointed peduncle, and of this the second and principal joint carries on the upper part of its inner margin spines converted into coupling hooks. Of the two branches the outer is two-jointed, the inner one-jointed. Sometimes there is only a one-jointed outer branch, and sometimes in place of well-developed pleopods there are mere rudiments, or a group of setæ. In the

Cumidæ the inner branch has a little process on the outer margin carrying the supposed auditory hairs.

The appendages of the sixth pleon-segment, the uropods, almost always have the peduncle elongate. The inner branch may consist of one, two, or three joints, while the outer appears to be always two-jointed. Living Cumacea will be seen repeatedly to double this caudal fork back upon the head, some species being in the habit of folding it dorsally and others ventrally. Eugène Hesse remarks that he has frequently seen these animals pass the different appendages of the body and the mouth-organs successively between the uropods as if between the teeth of a comb. These appendages are often plentifully supplied with spines and hairs, so that they can well fulfil the functions both of brush and comb in the creature's toilet. Like so many other marine animals, which live in conditions very unpromising for cleanliness, these can probably keep themselves exquisitely neat when they so desire, although if they are killed with the mud and slime upon them, it is extremely difficult for human fingers to cleanse the specimens without inflicting damage. The tail part in the Cumacea has the advantage of being very conspicuously displayed, and the combined characters of the telson and uropods, or, when there is no articulated telson, the characters of the uropods alone, will suffice to determine the genus to which a specimen belongs.

The shape and armature of the carapace are of the highest importance for specific distinction, but the characters are not always especially easy to observe, and the matter is complicated by the differences which prevail not only between the males and females, but between the forms of the male at different periods of life. Normally the antero-lateral angles of the carapace are produced so as to surround the front of the head, and by meeting above to form a sort of rostral process. The median fissure of this quasi-rostrum being continued backwards on either side gives a kind of trilobed appearance to the head. Occasionally, as in *Vaunthompsonia cristata*, Spence Bate, the ocular prominence of the head projects so far that the

lateral angles of the carapace close it in only at the sides and not in front.

The marsupium of the female is formed by the splitting of the ventral wall of the segments which carry the third maxillipeds and the first three pairs of peræopods, the upper lamina separating the pouch from the general body-cavity. Only in the aberrant Isopod genus *Gnathia* (wrongly called *Anceus*) has any correspondent arrangement for the marsupium been observed, although there the ventral wall serves the purpose without being split into two laminæ.

The body contains an oval or spindle-shaped heart, extending from about the middle of the carapace back through two or three of the free segments. It has one pair of lateral venous openings. At the sides of it are two elongate organs with some excretory function. The liver-tubes are usually three pairs, but there is only a single pair in the family Campylaspidæ. The nervous system comprises the supraœsophageal ganglion or brain, and sixteen ganglia, of which the first three in close contiguity innervate the parts of the mouth. The next seven belong to the trunk and are connected by rather long double commissures. The remaining six, pertaining to the pleon, are weakly developed, and their connecting commissures are very long and slender.

It is a rather singular circumstance that the telson is large and conspicuous only in two out of the eight families. In one other family it is distinct, but small and without spines. In the remaining five families it is entirely wanting, except so far as the ventral opening may vouch for its existence, and a slight prolongation of the sixth pleon-segment may suggest that it is not wholly lost but coalesced.

Of the characters given the combination of a very few will suffice to distinguish the Cumacea from all other Edriophthalma.

Definition of the sub-order Cumacea.

The carapace covers the segments of the head and all but the last five segments of the trunk. The antero-lateral lobes are drawn towards one another usually in advance of the frontal region. The first maxillipeds carry a respiratory organ of which the hinder division almost always is furnished with branchial sacs, and the front division forms an exserted tube during respiration for the outflow of water from the branchiæ. Of the peræopods at fewest the first pair have exopods. Of the pleon-segments the fifth is the longest. The appendages of the sixth are the only pair of uropods.

The eight families included are the Cumidæ, Vaunthompsoniidæ, Leuconidæ, Nannastacidæ, Campylaspidæ, Pseudocumidæ, Lampropidæ, Diastylidæ.

The peculiarity of the fifth pleon-segment being the longest is reproduced in the curious Isopod genus *Phreatoicus*, Chilton, which is otherwise nearer the Amphipoda.

Family 1.—*Cumidæ.*

The first antennæ are very small, with one of the flagella rudimentary; the second antennæ in the male have the filiform flagellum composed of many short joints. The mandibles have the anterior branch produced and armed with a dense lateral series of spines. The epipod of the first maxillipeds is very large, with the branchial sacs numerous, leaf-like, in a straight series. The third maxillipeds have some of the joints expanded and laminar. Only the first pair of peræopods in either sex have well-developed exopods. The male has five pairs of pleopods well developed. The inner branch of the uropods is one- or two-jointed; the telson is wanting. Five genera are included in this family.

Cuma, Milne-Edwards, 1828, has the carapace moderately developed, only four segments of the trunk distinct behind it; the eye well developed; the third maxillipeds with the second joint apically

produced; the uropods with the peduncle elongate, and the inner branch generally two-jointed.

Cyclaspis, Sars, 1865, agrees with the above characters of *Cuma*, except that the carapace is swollen, almost globular, the eye is not always present, the peduncle of the uropods is not greatly elongate, and the inner branch is one-jointed.

Iphinoe, Spence Bate, 1856, has the body slender, compressed, five segments of the trunk distinct behind the carapace; the eye distinct; the second joint of the third maxillipeds produced; the second joint of the inner branch of the uropods elongate.

Cumopsis, Sars, 1879, has five segments of the trunk distinct behind the carapace; the eye well developed; the second joint of the third maxillipeds not produced. The second and third pairs of peræopods have one-jointed setiferous exopods.

Stephanomma, Sars, 1871, is uniquely devoid of the frontal bifurcating suture; it has five segments of the trunk distinct behind the carapace. The eye (in the type species, *Stephanomma Goësii*, Sars) forms a coronet or circlet of eleven ocelli.

Of the genera thus briefly distinguished, *Cuma*, 'a wave,' has given its name to the whole sub-order, although not in fact the earliest named genus in it. *Cuma scorpioides* (Montagu, 1804) is a British species. The carapace is strong and strongly ridged longitudinally. The inner branch of the uropods is two-jointed. In Bell's 'History of the British Crustacea' a lamentable confusion is made. It quotes in full Goodsir's descriptions of his own *Cuma Edwardsii* and Milne-Edwards' *Cuma Audouinii*, but, as Sars has pointed out, the figures copied under the heading *Cuma Audouinii* belong to *Cuma Edwardsii*, and *vice versâ*. As a matter of fact Goodsir's *Cuma Edwardsii* is a synonym of *Cuma scorpioides* (Montagu). *Bodotria arenosa*, Goodsir, is, I think, a distinct species of *Cuma*, separated from the other four species of that genus by having the inner branch of the uropod single-jointed.

The minute *Cuma pulchella*, Sars, has recently been taken by Mr. Thomas Scott in the Firth of Forth.

Cyclaspis, 'with orbed carapace,' contains seven species, one of which *cornigera*, Sars, by the pair of horns on the sides at the anterior part of the carapace is a very marked form. *Cyclaspis levis*, G. M. Thomson, and *Cyclaspis pusilla*, Sars, are notable for having the carapace entirely devoid of spines and sculpturing.

Iphinoe trispinosa (Goodsir) is plentiful in some British waters. The number of spines or teeth on the central crest of the carapace is far from being always limited to three. In the males these teeth are always set away from the front of the carapace, and sometimes in that sex there are none, though it is doubtful whether this is so frequently the case that it can be called the rule. *Iphinoe tenella*, Sars, has recently been taken in the Clyde.

Cumopsis contains two species which are both British, one, *Cumopsis Edwardsii* (Spence Bate), which was placed successively in *Cuma*, *Vaunthompsonia*, and *Bodotria*, till Sars established a new genus for it, and the other, *Cumopsis longipes* (Dohrn), the specific name of which has priority over *lævis* given by Sars.

Family 2.—Vaunthompsoniidæ.

General form, first antennæ and mandibles, pleopods and absence of telson, are as in the Cumidæ. The flagellum of the second antennæ in the male is composed of long slender joints. The epipod of the first maxillipeds in the female is very narrow, with few, finger-like branchial sacs arranged in a semicircle. The third maxillipeds have the joints scarcely expanded. The first three pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. The inner branch of the uropods is two-jointed.

There are at present three genera.

Vaunthompsonia, Spence Bate, 1858, has the body not very slender, scarcely compressed; the eye distinct; the second joint of the third maxillipeds not produced; the

second pair of peræopods spinose, with the third joint not defined; the fourth pair in the female without any rudiment of the exopods. *Vaunthompsonia cristata*, Spence Bate, is British. The only other species, *Vaunthompsonia meridionalis*, Sars, is from Kerguelen. *Vaunthompsonia anomala*, Sars, is supposed by its author to represent in all probability another distinct genus.

Leptocūma, Sars, 1873, has the body elongate and much compressed, the eye indistinct, the third joint in the second peræopods defined, and the fourth peræopods in the female with rudimentary exopods. The single species is *Leptocuma Kinbergii*, Sars, taken off the mouth of the Rio de la Plata.

Heterocūma, Miers, 1879, has the eye well developed, and the second joint of the third maxillipeds produced. It has the single species *Heterocuma Sarsii*, Miers, with a variety, *granulata*.

Family 3.—*Leuconidæ*.

The form is generally slender with elongate pleon. The eye is wanting. The first antennæ have one of the flagella small, one-jointed. The anterior branch of the mandibles is without the usual series of spines, the molar tubercle is massive. The 'palp' of the first maxillæ has a single terminal seta. The epipod of the first maxillipeds has few, finger-like branchial sacs. The third maxillipeds are rather short, with some strong setæ on the outer margin. The first three pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. The second pair of peræopods are only six-jointed. There are only two pairs of pleopods in the male. The inner branch of the uropods is two-jointed, spinose, the outer being setose. The telson is wanting.

The family contains three genera.

Leucon, Kröyer, 1846, has the body slender, the pseudo-rostral projection distinctly prominent, and the first antennæ not geniculate. There are eleven species known, of which the oldest *Leucon nasīca*, Kröyer, has been recorded from British waters.

Eudorella, Norman, 1867, is a name substituted for the preoccupied *Eudora*, Spence Bate, 1856. It has an oval orifice between the antero-lateral lobes of the carapace, the pseudo-rostral projection wanting, and the first antennæ geniculate between the last two joints. It contains eight species. among which *Eudorella emarginata* (Kröyer) and *Eudorella truncatula* (Spence Bate) are British.

Eudorellopsis, Sars, 1882, has the body short and stout, the median lobe of the carapace not excavate, and the first antennæ geniculate between the first two joints. It contains two species, *Eudorellopsis deformis* (Kröyer) and *Eudorellopsis integra*, S. I. Smith.

Family 4.—*Nannastacidæ.*

There may be either one eye or two eyes. The first antennæ are alike in both sexes, the flagella very unequal, the smaller one- or two-jointed. The flagellum of the second antennæ in the male has rather long slender joints. The mandibles have few spines on the anterior branch. The epipod of the first maxillipeds has the branchial sacs in the female very slightly developed. The third maxillipeds have the terminal part irregularly flexuous. The first two pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. The last three pairs of peræopods are very slender and end in a curved finger. The pleopods are wanting in both sexes. The inner branch of the uropods is one-jointed. The telson is wanting.

Sars calls this family the Cumellidæ, but Spence Bate's name Nannastacidæ has clear priority. It contains three or four genera.

Nannastăcus, Spence Bate, 1865, means 'a dwarf lobster.' It has two distinct compound eyes. The carapace is broad in front or with elongate pseudo-rostrum. The British species, *Nannastacus unguiculatus*, Spence Bate, and *Nannastacus Suhmii*, Sars, from the Philippines, have the

peduncles of the uropods very short, but the Mediterranean *Nannastacus longirostris*, Sars, has these peduncles tolerably long. Kossmann has instituted *Nannastacus Sarsii* from the Red Sea.

Diops, Paulson, 1875, as its name implies, has two separate eyes, and may be the same as *Nannastacus*, but the species *parvulus* and *spinosus* are represented with the carapace much narrowed in front, and it is difficult to make them agree with any recognised species of *Nannastacus*.

Cumella, Sars, 1865, has but one eye. Of the two species, *pygmaea*, Sars, and *limicola*, Sars, the former is found in British waters.

Spencebatea, Norman, 1879, has the uropods greatly developed, with the peduncle much longer than the branches, although the inner of these consists of a long joint and a greatly developed terminal spine. Canon Norman informs me by letter that it has an eye. The single specimen, measuring a sixth of an inch, of the single species, *Spencebatea abyssicola*, Norman, was taken in 1,360 fathoms, in lat. 54° 53′ N., long. 10° 56′ W., west of Donegal Bay.

Family 5.—*Campylàspidæ.*

The carapace is strongly arched behind. The first antennæ are alike in both sexes, with one of the flagella obsolete. The flagellum of the second antennæ is composed of long and slender joints. The mandibles have the anterior branch obliquely truncate and toothed, the molar process narrow, stiliform. The first maxillæ are very large, the second feeble. The terminal part of the first maxillipeds is obsolete, the narrow epipod has the branchial sacs arranged in a semicircle. The second maxillipeds have the penultimate joint swollen. The third maxillipeds closely resemble the first peræopods. The first two pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. The pleopods are wanting in both sexes. The

inner branch of the uropods is one-jointed. The telson is wanting.

The single genus, *Campylaspis*, Sars, 1865, is well marked by the enormous development of the carapace, which usually bulges backward over some of the free segments of the trunk. Sars has found in this genus the liver consisting of only a single pair of cæcal tubes instead of three pairs. Thirteen species have been described, eleven of them by Sars himself, the other two being *rubicunda* (Lilljeborg) and *carinata*, Hansen. *Campylaspis costata*, Sars, has been recorded from the Clyde by Mr. Thomas Scott, F.L.S.

Family 6.—*Pseudocumidæ.*

The first antennæ have oue of the flagella rudimentary. The flagellum of the second antennæ is composed of rather long slender joints. The anterior branch of the mandibles has few spines. The epipod of the first maxillipeds has only slight traces of branchial sacs. The first two pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. The male has but a single pair of well-developed pleopods. The inner branch of the uropods is one-jointed. The telson is distinct, but very small, and unarmed.

The family contains two genera.

Pseudocūma, Sars, 1865, has an eye; there are two-jointed rudimentary exopods on the third and fourth pairs of peræopods in the female, and in the male rudimentary pleopods on the second segment of the pleon, and plumose setæ in place of pleopods on the third, fourth, and fifth segments. *Pseudocuma longicornis* (Spence Bate) is an abundant British species, often spoken of as *Pseudocuma cercaria* (van Beneden), but Bate's name is the older. In speaking of the species as British, it will be understood that there is no intention to exclude any number of other localities. *Pseudocuma ciliata*, Sars, is the only other species in the genus, and this it would be better to call *ciliatus*, since, if the gender of the generic name is attended to, it would rather become *ciliatum* than *ciliata.*

For Sars's *Petalomēra*, 1882, and *Petalŏpus*, 1865, both preoccupied, I propose *Petalosarsia.* It has no eye. The last segment of the trunk is firmly united to the preceding. The first peræopods are devoid of the seventh joint and have the so-called merus or fourth joint like a petal or leaf, an expansion which is unique. There are no rudimentary exopods on the third and fourth pleopods of the female, nor rudimentary pleopods on the second to the fifth pleon-segments of the male. The single species is *Petalosarsia declīvis*, Sars, from the Lofoden Islands and Spitzbergen. It has been recently taken in the Firth of Forth.

Strauchia, Czerniavsky, 1869, is described as having exopods on the second and third peræopods in the female, and none on the first, which would require for it the institution of a separate family, Strauchidæ. But probably allowance should be made for some mistake in the description, as the single specimen of the single species, *Strauchia taurica*, Czerniavsky, is said to be about a twenty-fifth of an inch long! A small distinct telson is attributed to it, which rather points to its position among the Pseudocumidæ, but this species from the Black Sea is at present involved in obscurity.

Family 7.—*Lampropidæ.*

The first antennæ have both flagella well developed and nearly equal. The flagellum of the second antennæ in the male is composed of many short joints. The epipod of the first maxillipeds has few finger-shaped branchial sacs. The first two pairs or only the first pair of peræopods in the female and the first four pairs in the male have well-developed swimming-branches. In the male there are three pairs of pleopods or none. The branches of the uropods are very slender, the inner three-jointed. The telson is distinct, with three or more terminal spines.

There are five genera.

Lamprops, Sars, 1863, meaning 'bright-eyed,' has the flagellum of the second antennæ in the male relatively short and prehensile; the third and fourth peræopods in

the female carry rudimentary exopods in the shape of two-jointed setiferous appendages; the male has no pleopods. *Lamprops fasciata*, Sars, is found in Great Britain as well as Norway. In the female the carapace has three oblique lateral folds. The telson terminates in five spines. *Lamprops fuscata*, Sars, has the carapace smooth in both sexes. *Lamprops quadriplicata*, S. I. Smith, from the north-east coast of America, has four lateral folds on the carapace.

Hemilamprops, Sars, 1882, has the flagellum of the second antennæ in the male filiform and as long as the body; the third and fourth peræopods in the female with rudimentary exopods; and three pairs of pleopods in the male. *Hemilamprops rosea* (Norman) is British and Norwegian. It has the telson ending in seven or eight spines. *Hemilamprops cristata*, Sars, from the same localities, has the telson ending in three spines, in which it agrees with the Norwegian *Hemilamprops uniplicata*, Sars. The remaining species, *Hemilamprops assimilis*, Sars, has the eye rudimentary, and the telson ending in six spines.

Paralamprops, Sars, 1887, has no eye. The first maxillæ are without 'palp,' this defect being unique in the sub-order. The third and fourth peræopods in the female have rudimentary two-jointed exopods, and the male has three pairs of pleopods. The single species, *Paralamprops serrato-costata*, Sars, was obtained by the *Challenger* at Kerguelen Island.

Platyaspis, Sars, 1870, has no eye. Only the first peræopods in the female have swimming-branches, instead of the first two pairs as in the preceding genera of this family. The male has three pairs of pleopods. The single species is *Platyaspis typica*, Sars.

Chalarostylis, Norman, 1879, has the flagellum of the second antennæ in the male reaching to the end of the trunk. There are three pairs of pleopods in the male. The uropods are remarkably long and slender. The telson is short, ending in three spines. The female is unknown. *Chalarostylis elegans*, Norman, taken by the *Porcupine* off Rockall, in 109 fathoms, is the only species. It may or may not have an eye, but none has yet been perceived.

Family 8. —*Diastylidæ.*

The first antennæ are more or less unlike in the two sexes, the flagella unequal, the smaller being three-jointed in the female. The anterior branch of the mandibles has

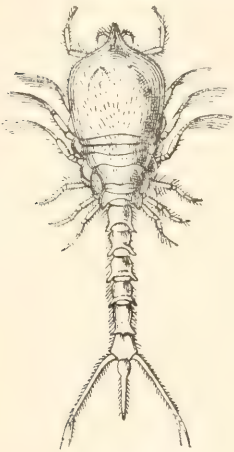


FIG. 26.—*Diastylis Goodsiri*, dorsal view of female [Hansen].

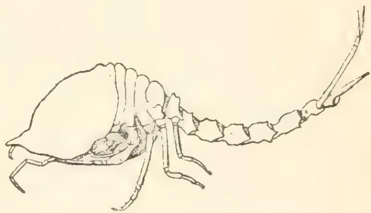


FIG. 27.—*Diastylis Goodsiri*, lateral view of female [Hansen].

a dense series of lateral spines. The epipod of the first maxillipeds has the branchial sacs arranged more or less spirally. The third maxillipeds have the second joint very large and curved. The first two pairs of peræopods in the female and the first four in the male have well-developed swimming-branches. There are only two pairs of pleopods in the male, and of these the second is sometimes imperfectly developed. The uropods have the inner branch two- or three-jointed. The telson is distinct, generally narrowed terminally, with only two spines at the apex.

The family includes three genera.

Diastylis, Say, 1818, is the earliest in date of the Cumacean genera, and in Lepechin's *Oniscus scorpioides*,

1780, it possesses the earliest in date of the Cumacean species, unless the doubtful *Gammarus esca*, Fabricius, 1779, be allowed precedence. The name is evidently based on a Greek word meaning 'with an interval between the columns,' and in this Greek word the penultimate syllable is long, but the interval referred to is not really between columns, as implied by the Greek stȳli, but between the stilets or slender-branched uropods, to which the Latin word stĭli is appropriate. But to pronounce the name as *Diastÿlis* in accordance with this correction would make a hybrid of it, and it cannot therefore be recommended. This genus has the second antennæ in the male very fully developed, attaining the length of the body. The third and fourth peræopods in the female have no rudimentary exopods. The genus is widely distributed, and includes thirty species or more. Several of these are recorded by Norman, Robertson, and others, from British waters, as: *Diastylis Rathkii* (Kröyer), *Diastylis cornuta*, Boeck, *Diastylis insignis*, Sars, *Diastylis echinatus*, Spence Bate, *Diastylis biplicata*, Sars, *Diastylis spinosa*, Norman, *Diastylis lævis*, Norman, *Diastylis rugosa*, Sars, *Diastylis tumida* (Lilljeborg), *Diastylis lamellata*, Norman.

Leptostylis, Sars, 1869, has the second antennæ of the male less fully developed than in the preceding genus, and has rudimentary exopods on the third and fourth peræopods in the female. The genus includes six species, of which *Leptostylis producta*, Norman, is British.

Diastylopsis, S. I. Smith, 1880, like *Diastylis*, has no rudimentary exopods on the third and fourth peræopods of the female, but it is distinguished by the unique character of having the third and fourth free segments of the peræon consolidated. To the American species, *Diastylopsis Dawsoni*, Smith, must be added *Diastylopsis resīma* (Kröyer), which is well marked by the upturned nose or pseudorostrum, to which the specific name refers.

By aid of the accompanying table the student will be able to assign his specimens to their proper families, which will be found a very useful preliminary to the more difficult task of discovering the genus and the species :—

Telson	Uropods. No. of joints to the inner branch	Pleopods. Pairs well developed in the male	Peræopods. No. of pairs with exopods fully developed	Mandibles	First antennæ	Eyes—Present + Absent 0	
Wanting .	2 or 1	5	♀ 1. ♂ 1	—	—	+ or 0	Cumidæ
	2	5	♀ 3. ♂ 4	with many spines	—	+ (or 0)	Vaunthompsoniidæ
	2	2	♀ 3. ♂ 4	without spines	—	0	Leuconidæ
	1	0	♀ 2. ♂ 4	—	secondary flagellum 1- or 2-jointed	1 or 2	Nannastacidæ
	1	0	♀ 2. ♂ 4	—	one of the flagella obsolete	+ or 0	Campylaspidæ
Very small, unarmed . .	1	1	♀ 2. ♂ 4	—	—	+ or 0	Pseudocumidæ
Large, with 3 or more terminal spines .	3	3 or 0	♀ 1 or 2. ♂ 4	—	3-jointed flagella nearly equal	+ or 0	Lampropidæ
Large, with only two terminal spines . .	2 or 3	2	♀ 2. ♂ 4	—	2- or 3-jointed flagella unequal	+ or 0	Diastylidæ

According to the table the family can always be ascertained by the external characters, except in the case of the females of the Vaunthompsoniidæ and Leuconidæ, and there the eye is generally available, since it is absent from all the Leuconidæ, and indistinct only in one genus, *Leptocūma*, of the Vaunthompsoniidæ. The Campylaspidæ, which in the table are but slightly distinguished from the Nannastacidæ, are strongly distinguished externally both from them and all other Cumacea by the backward bulging carapace, as also by the stiliform molar process of the mandibles and internally by the single pair of liver tubes.

The genealogical relationships of the Cumacea are obscure. The second antennæ of the male resemble what is often seen in the Amphipoda. The epipod of the first maxillipeds helps the respiration, as in the Mysidæ and cheliferous Isopods, but with the important addition of sessile branchial sacs. In the swimming branches on some of the peræopods there is a weighty resemblance to the Mysidæ. The mouth-organs make some approaches to those of the Isopoda, and, as with them, the young are hatched before the development of the last pair of peræopods. The pleon recalls the palæozoic Phyllocarida and their existing representative *Nebalia*.

It will have been seen by the number of genera and species to which the name of G. O. Sars is attached that he has made a special study of this sub-order, and this sketch of it is deeply indebted to his numerous and luminous works upon the subject, to which, indeed, must be credited the clearness and accuracy with which this small but very interesting group is now known.

CHAPTER XXI

ISOPODA

Tribes.	*Families.*	
Chelifera	Apseudidæ, Tanaidæ	
Flabellifera	Anthuridæ, Gnathiidæ	
	Cirolanidæ, Corallanidæ, Alcironidæ, Barybrotidæ, Ægidæ, Cymothoidæ	Cymothoid group
	Serolidæ, Sphæromidæ, Limnoriidæ	
Valvifera	Arcturidæ, Idoteidæ	
Asellota	Asellidæ, Munnopsidæ	
Phreatoicidea	Phreatoicidæ	
Epicaridea	Microniscidæ, Cyproniscidæ, Dajidæ, Cabiropsidæ, Cryptoniscidæ, Entoniscidæ, Bopyridæ	
Oniscoidea	Ligiidæ, Tylidæ, Helleriidæ, Oniscidæ, Armadillididæ	

Suborder 2.—Isopŏda.

The Isopoda form a vast and widely distributed army. In contrast with the distinctive uniformity of the Cumacea, they exhibit an extreme diversity of shape. The name was

formed by Latreille from the Greek words ἴσος, equal, and πούς, a foot, but, so far from the legs being all alike or equal as the name would imply, these appendages often have two or three very different developments in a single animal. There is, to be sure, a typical form of limb which prevails very widely, but the exceptional forms are numerous and remarkable. With these Latreille was unacquainted, and therefore naturally gives no clue to them in the name Isopoda, which he himself interprets as signifying 'tous les pieds simples et uniquement propres à la locomotion ou à la préhension.' In proportion to their importance in the economy of the world the Isopoda have hitherto attracted little of popular notice. They enjoy still less of popular favour. They are all of retiring habits, never needlessly courting attention, but in general clinging as closely as possible to whatever shelter or holdfast they have adopted. Amidst enormous disparities of size and strength and shape and temper, this prudent love of obscurity, the one feature of the moral character which all of them possess in common, is strong evidence that all of them must have sprung from a common origin. They have never tempted mankind to search for them as food. The services which they doubtless often render as effective scavengers are in some measure counterbalanced by the damage which some of them inflict on submarine structures and the depredations committed by others on the fruits of the garden. Several of the species treat their fellow-inhabitants of the sea with little ceremony, and make up for smallness of size by ferocity of behaviour. It is only to be hoped, as indeed it may be considered certain, that their living victims are immeasurably less sensitive to pain than ourselves.

Normally the members of this sub-order have an elongate ventrally flattened body, divided into a head of six segments under a carapace, a trunk or peræon of seven articulated segments, and a pleon usually limited to six segments. As in all the Edriophthalma, there is no appreciable ocular segment. The carapace is occasionally in coalescence with one or two of the segments of the

peræon. The six segments of the pleon may be all articulated, or some or all of them fused together. The seventh segment or telson is scarcely ever free, but its independent existence is indicated in the peculiar genus *Phreatoicus*, and in one tribe, the Flabellifera, its presence may generally be inferred from the attachment of the uropods high up on the sides of the terminal segment, while a few of the genera, as *Paranthura*, have it distinctly articulated.

A pair of sessile compound eyes, remote or contiguous, are usually present, but may be entirely wanting. Occasionally they project from the head, but never on movable foot-stalks.

The first antennæ are never very elongate, and rarely have a secondary flagellum. The second antennæ very seldom carry an exopod, the articulated scale so common among the Macrura. The upper lip usually forms a plate projecting from the top of the oral aperture over the cutting edges of the mandibles, and may have an inner plate lying parallel to the outer. The lower lip is bilobed, or forms two pairs of lobes, of which the inner pair is much the smaller. The mandibles are very variable, the dentate cutting edge, secondary plate, spine-row, molar tubercle, and three-jointed 'palp,' being sometimes strongly developed, at others, some or even all of them disappearing. The first maxillæ very rarely have a backward directed 'palp.' The second maxillæ have neither 'palp' nor exopod; the outer plate is divided, the inner undivided. The maxillipeds, of which the first are in this and the next sub-order the only pair, often have an epipod on the first joint. This first joint as a rule stands free in each maxilliped, the pair not being fused together. The plate developed from the second joint is provided with coupling spines. For the limbs of the trunk it is difficult to find any characters that are at all constant through the sub-order. Dr. Boas in his definition (1883) says that these seven pairs are strong running-feet with a spine at the point of the terminal joint; that the basal joint is always small, the second joint long, the third in the Tanaidæ smaller than those which follow,

elsewhere almost of the same size as these. But the exceptions to this statement are exceedingly numerous. Occasionally the first pair are opercular; often they have the form of gnathopods, that is to say, they are prehensile instead of ambulatory. Sometimes they are weak and slender, and agree in character with the three following pairs, at others they agree with only the next two pairs. Rarely the last three pairs are adapted for swimming instead of walking. The comparative lengths of the joints are also subject to much variation, although the second joint is scarcely ever shorter than the first or the third, the seventh pair of legs in *Phreatoicus typicus*, Chilton, and the first pair of the male in one or more species of *Munna*, offering perhaps rare exceptions. Marsupial plates are developed in the females in varying number. The peduncles of the pleopods often carry coupling spines. The two first pairs of the pleopods are often modified in the male as sexual organs. Usually the inner branch in some of the pairs is branchial. All the pairs are sometimes wanting. The uropods vary greatly both as to shape, function, and their position on the sixth segment. The liver is said to consist of four or six backward-directed tubes. The heart is generally but not always elongate, and usually in part situated in the pleon. The ovaries and testes are without a median section. The young usually quit the brood-pouch with the last peræopods still undeveloped.

While in the Cumacea the pleon is in general very considerably narrower than the trunk, in the Isopoda this is only rarely the case, and sometimes the pleon even exceeds the trunk in breadth.

Definition of the Sub-order Isopoda.

The cephalon or carapace with rare exceptions leaves free seven segments of the trunk. There are no branchial sacs in connection with the first maxillipeds, although these occasionally assist the respiration. Usually some of the pleopods have a branchial character. None of the last five pairs of trunk-limbs have natatory exopods. The first

three and generally the first five segments of the pleon are short, whether fused or articulated; the sixth comprising the telson is usually the largest, and its appendages constitute the only pair of uropods. The pleopods when present are almost always closely overlapping.

Instead of being contented with the single genus *Oniscus*, as in the first edition of Linnæus's 'System of Nature,' the Isopoda now occupy seven tribes, several of which are of great extent. These are named respectively Chelifera, Flabellifera, Valvifera, Asellota, Phreatoicidea, Epicaridea, and Oniscoidea.

Tribe 1.—*Chelifera.*

This first tribe, the 'claw-bearing' Isopods, is a comparatively small one, but it has many peculiarities and is controversially interesting. It has to do with narrow, subdepressed, or subcylindrical animals, in which the head is united with the first or even the first and second segments of the peræon. The segments of the pleon are sometimes fused together, and in that case the pleopods are wanting. Otherwise these appendages are generally present, and consist of a two-jointed stem and two unjointed branches, but differing from those of the Isopoda in general in being swimming rather than branchial organs. In this tribe respiration is carried on by means of a branchial chamber situated under the sides of the carapace to the rear. The first maxillæ have a backward-directed 'palp' similar to that described in the Cumacea, and no doubt fulfilling the same function of cleansing the branchial chamber from obstructions. It is supposed to be a part of the endopod turned backwards. The maxillipeds have also a remarkable structure directed backward into the branchial chamber. This by its attachment to the first joint is recognised as the epipod. By its rhythmical movement to and fro within the cavity it maintains a constant influx of water for the oxygenation of the animal's blood. In evident connection with this respiratory process in the front part of the body is the circum-

stance that the heart occupies the earlier segments of the peræon, whereas in those Isopoda which have branchial pleopods, the heart is correspondingly situated in and near the pleon. The tribal name refers to the fact that the first pair of trunk-limbs, or gnathopods (corresponding to the second maxillipeds of preceding descriptions), are furnished with a chela, the two terminal joints forming an opposed thumb and finger as in the familiar chelipeds of crabs and lobsters, a character not met with in the rest of the Isopoda. The uropods are slender, the branches often flagelliform. The eggs are carried in a marsupium of thin plates, which either form one pair attached to the fourth free segment alone, or four pairs attached to four segments.

The tribe includes only two families, the Apseudidæ and Tanaidæ, distinguishable by numerous characters both external and internal.

Family 1.—*Apseudidæ.*

The body is depressed, the carapace generally having a well-developed rostrum and carinate sides, with pyriform or spine-like ocular lobes. The segments of the pleon are well defined, narrower than those of the peræon.

The first antennæ, placed at the front corners of the carapace, are remarkable in this sub-order by having *two* many-jointed flagella. The second antennæ with the bases contiguous are placed between and below the first, and are often furnished with an articulated scale, ciliated all round. The flagellum is many-jointed.

The mandibles have a three-jointed 'palp.' The first maxillæ have two incisive lobes and a two-jointed backward-directed 'palp,' ending in two or more setæ. The second maxillæ are furnished with setæ and spines. The maxillipeds have a large laminar epipod, branchial in function. The first gnathopods are strong and chelate, the inner margins of the finger and thumb being usually tuberculate in the male and serrate in the female. The second gnathopods are fossorial, having the last three joints, especially the penultimate or 'hand,' flattened, the

flattened spines being of use for specific distinctions. One or both of the pairs have usually small two-jointed exopods. The peræopods are slender, with many setæ and spines. The pleopods have two long setiferous branches, and the uropods two that are many-jointed and filiform, the inner elongate.

The small exopods above mentioned, when seen only in cabinet specimens, might be considered rudimentary or of little importance. But this would not be a right way of regarding them. The branchial chamber has two little openings, one for the entrance, the other for the exit of the water used in breathing. In front of the latter of these orifices in the living animal, M. Yves Delage points out that the exopods of the first gnathopods with their terminal setæ vibrate so rapidly that the machinery can with difficulty be seen, while those of the second gnathopods behave in the same manner in front of the entrance apertures. By this contrivance a lively current of water is introduced to the branchial chamber, and, when its virtue has been exhausted, the parting guest is speeded to a convenient distance. When there is only one pair of exopods, it is those at the gate of egress which remain, and it is no doubt of less importance that the entering current should be rapid than that the used-up water should be effectively dismissed.

Five genera are at present assigned to this family. The ocular lobes are not movable, as they were at one time supposed to be.

Apseudes, Leach, 1814, has six segments of the trunk free, a well-developed scale on the second antennæ, a well-developed 'palp' on the mandibles, exopods on both pairs of gnathopods, and five pairs of pleopods, with both branches usually one-jointed.

Parapseudes, Sars, 1880, has six segments of the trunk free, the antennal scale rudimentary, the mandibular 'palp' very small, exopods on both pairs of gnathopods, and only four pairs of pleopods, which have one of the branches two-jointed. The single species is *Parapseudes latifrons* (Grube) from the Mediterranean. It was at one

time supposed to be without exopods on the first two pairs of limbs.

Sphyrăpus, Norman and Stebbing (in Sars), 1880, has only five segments of the trunk free, no antennal scale, exopods on the first, and sometimes if not always on the second, pair of gnathopods, and five pairs of pleopods.

Typhlapseudes, Beddard, 1886, 'the blind *Apseudes*,' shares a want of eyes with the genus *Sphyrapus* and with some species of *Apseudes*. Six segments of the trunk are free. It has a small antennal scale, but is said to be without exopod on either first or second gnathopods. There are five pairs of pleopods, in which one of the branches is two-jointed.

Leiŏpus, Beddard, 1886, 'the smooth-footed,' has six free segments of the trunk, a rudimentary antennal scale, a minute three-jointed exopod on the gnathopods of both pairs, and five pairs of pleopods, in which one of the branches is two-jointed. The type-species, *Leiopus leptodactўlus*, is described as having *three* joints to the palp of the first maxillæ, but 'the very short median joint' seems open to some suspicion.

The earliest known species of this family is *Apseudes talpa* (Montagu), first recorded from Devonshire, but also occurring in the Mediterranean. From *Apseudes Latreillii* (Milne-Edwards), also a British species, it may be distinguished by the serrate first joint of the first antennæ, the spines on the epistome and on the ventral surface of the peræon-segments, and the elongation of the last segment of the pleon. Other species, such as *Apseudes simplicirostris*, Norman and Stebbing, 'taken in 1,263 fathoms, about one hundred miles directly south of Rockall, *Porcupine* Expedition, 1869,' and *Apseudes grossimănus*, Norman, from 90 fathoms, long. 11° 40′ W. off the south-west coast of Ireland, may be technically regarded as British, but these and others in like circumstances seldom come into the hands of any students but those who will prefer to consult the original memoirs for their characteristics. *Sphyrapus malleŏlus*, Norman and Stebbing, alludes both by its generic and its specific name to the hammer-like

appearance of the first gnathopods, especially in the male, in which sex the huge hand is set on at right angles to the preceding handle-like joint. Like *Sphyrapus tudes*, of the same authors, it has been taken off the west of Ireland. From the latter species it is distinguished by the great extension of the lateral processes on the second segment of the pleon.

In both of these species there are exopods on both pairs of gnathopods, but, according to Sars, they are absent from the second pair in his species, *anomalus* and *serratus*.

Family 2.—*Tanaidæ.*

The body is nearly parallel-sided, the carapace being truncate in front or with a minute rostrum, with or without ocular lobes and eyes. The peræon and pleon are without spiny armature. The pleon is seldom narrower and sometimes broader than the peræon. The first antennæ are contiguous, with a single flagellum, which is rudimentary or sometimes wanting or rarely well developed in the female, but multiarticulate in the male. The second antennæ are smaller than the first and below them, without scale, and with the flagellum rudimentary or rarely well developed. The mandibles have no 'palp.' The first maxillæ have one incisive lobe and a one-jointed 'palp' usually ending in two setæ. The second maxillæ form minute rudimentary unarmed lobules. The maxillipeds are fused at the base, and usually have a narrow falciform epipod. The masticatory organs are, however, often evanescent in the adult male. The gnathopods are without exopods. In the first pair the second joint is large and tumid, and in the adult male the sixth joint or hand becomes so much developed that it seems to crowd the mouth-organs out of existence. The second gnathopods are ambulatory like the following limbs. The pleopods have two short setiferous branches, or are rarely absent. The uropods are either simple or furnished with two filaments, of which the outer is always short, having one, two, or at most three, joints.

Within recent years the genera of this family have become tolerably numerous. Many of the species are quite microscopic, and in some instances an impatient observer may be tempted to suppose that the distinguishing features even of the genera have been invented to match the size of the specimens. But in most cases such a criticism will be withdrawn upon a more careful inspection.

Only a few selected characters can here be offered to discriminate the fifteen (or rather, the fourteen) genera that have been established:—

Tanais, Audouin and Milne-Edwards, 1829, has eyes, several setæ on the 'palp' of the first maxillæ, the marsupium of the female consisting of two large plates affixed to the fourth free segment of the peræon, only three pairs of pleopods, and the uropods simple, the single branch being two- or three-jointed.

Leptochelia, Dana, 1849, has two setæ on the 'palp' of the first maxillæ, the first gnathopods of the adult male with very elongate thumb and finger, the marsupium of the female consisting of a pair of plates on each of the first four free segments, five pairs of pleopods, and in the uropods a multiarticulate inner and a one-jointed outer branch.

Heterotanais, Sars, 1880, scarcely differs from *Leptochelia*, except in the first gnathopods of the male, which are incompletely chelate, the so-called thumb being very little instead of enormously produced. In the uropods the outer branch is little but two-jointed, the inner filiform, with four or five joints.

Paratanais, Dana, 1852, has eyes, but without distinct ocular lobes. The mandibles are strong in the female, with cylindrical molar process, whereas in the male all the mouth-organs, except the maxillipeds, are lost. The first gnathopods are similar in the two sexes. Of the uropods both branches are two-jointed.

Pseudotanais, Sars, 1880. The eyes are imperfect or absent, and there are no ocular lobes. The mandibles have a stiliform molar. The maxillipeds are fused at the

base, a single central plate issuing between the 'palps' from the fused second joints. The marsupium is like that in *Tanais.* There are five pairs of pleopods in the male, and five or none in the female. The uropods have both branches two-jointed.

Typhlotanais, Sars, 1880, is without eyes or ocular lobes. The mandibles have a thick cylindrical molar in the female. In the male the mouth-organs disappear as in *Paratanais.* The marsupium has the usual four pairs of plates. There are five pairs of pleopods in both sexes. Both branches of the uropods are two-jointed, or one or other of them may be one-jointed.

Leptognathia, Sars, 1880, has no eyes or ocular lobes. The mandibles are weak, with a feeble pointed molar in the female. The mouth-organs of the male and marsupium of the female and the pleopods are as in the preceding genus. Of the uropods the inner branch is two-jointed in the female, three-jointed in the male, the outer much smaller, two- or one-jointed, sometimes rudimentary.

Alaotanais, Norman and Stebbing, 1886, has minute ocular lobes, but no eyes. The mandibles are strong, with large molar, at least in the female, the full-grown male being probably content with the maxillipeds for mouth-organs. The marsupium and pleopods are as in the preceding genus. The first gnathopods are powerful, especially in the male, much like those of *Leptochelia.* Of the uropods the inner branch is eight- or nine-jointed, the outer two-jointed.

Neotanais, Beddard, 1886, is no doubt the same genus as the preceding. Both were published by the Zoological Society of London in the same year. The description of *Alaotanais* was received Nov. 5, 1884, read Dec. 2, 1884, and published in October 1886. *Neotanais* was, I believe, received and read considerably later, but actually published earlier. Mr. Beddard mentions 'mandibles with the usual structure, with a slender extremity and a stout molar process.' His only specimens were males, but not perhaps at the stage when the mandibles would be lost.

Bathytanais, Beddard, 1886, has distinct ocular lobes,

with eyes well developed, and the first and second antennæ four-jointed apparently in the male as well as in the female. The male is thought to be distinguished chiefly by a more elongate pleon. The single species is represented by one small specimen supposed to come from 2,050 fathoms in Mid Pacific, and other specimens from between 2 and 10 fathoms at Port Jackson in Australia.

Tanaella, Norman and Stebbing, 1886, has no eyes and no distinct ocular lobes. There are no pleopods in the female, and the uropods are simple, the single branch being also single-jointed. The male is unknown.

Strongylūra, Sars, 1880, has no eyes and no distinct ocular lobes. The mandibles have the molar moderately large, laminar. There are no pleopods in the female. In the uropods the inner branch is two-jointed, the outer one-jointed.

Cryptocōpe, Sars, 1880, like several of the preceding genera is without eyes. The mandibles have the molar sublaminar, unarmed, and on the right hand mandible there is a very prominent secondary plate. The segments of the peræon are divided by deep instrictions. The pleopods are well developed in the male, rudimentary in the female. The uropods in the male are long, with three-jointed inner, and two-jointed outer, branch; in the female short, with two-jointed inner, and one-jointed outer, branch.

Haplocōpe, Sars, 1880, agrees nearly with the preceding genus, except that the mandibles have a cylindrical molar, of which the truncate apex is encircled with teeth, and the uropods are moderately long with unequal two-jointed branches.

Anarthrūra, Sars, 1880, is distinguished from all the foregoing genera by having the pleon unsegmented. There are no eyes. The hands of the first gnathopods are weak. There are no pleopods. In the uropods the outer branch is represented by a conical process not disunited from the peduncle, the inner branch is two-jointed.

Among the earlier authorities on this family the writings of Kröyer, Lilljeborg, and Fritz Müller may be men-

tioned as of special importance. For more recent information the student should consult Sars's two papers on the 'Isopoda Chelifera' published in 1880 and 1886, and that by Norman and Stebbing on the Isopoda of the *Lightning*, *Porcupine*, and *Valorous* Expeditions, in the 'Transactions of the Zoological Society' for the latter year. The last-mentioned paper enumerates thirteen genera and forty-six species of Tanaidæ as occurring in the North-Atlantic and Mediterranean, *Typhlotanais* and *Leptognathia* being each credited with ten species and *Leptochelia* with five.

Tanais tomentosus, Kröyer, 1842, has been identified with *Tanais vittatus* (Rathke), 1843. In Devonshire in timbers washed by the tide it occurs in company with *Limnoria lignorum* and *Chelura terebrans*. In America the same association is reported of *Tanais filum*, Stimpson, which may, however, be a *Leptochelia*. The Egyptian species, *Tanais Dulongii* (Audouin), is by Bate and Westwood enrolled in the fauna of Devonshire, though their only specimens came from Polperro, in Cornwall. They are with some reason doubtful about the identification, and the rediscovery of their species in Great Britain is still awaited. They curiously include in the synonymy the *Tanais Dulongii* of Thompson and of White, though acknowledging in the text that these Irish specimens had proved to be mutilated Amphipods. They speak of the third peræopods, or fifth pair of trunk limbs, in this species as carrying branchial organs, which would be a peculiarity of no little importance, were it not practically certain that the supposed branchiæ were merely the marsupial plates of a female specimen.

The species which Bate and Westwood name *Leptochelia Edwardsii* (Kröyer) should rather be called *Leptochelia Savignyi* (Kröyer), as the earlier description belongs to that name. Kröyer's *Tanais Edwardsii* is the male of the same species. *Leptochelia algicŏla*, Harger, from New England, is, according to Sars, in the female a synonym of this species, while in the male it is a synonym of *Leptochelia dubia* (Kröyer). Fritz Müller, and after him Dr. Dohrn,

supposed that in *Tanais dubius*, Kröyer, there were two forms of the male, but Sars considers that of the two supposed forms one is *Leptochelia dubia* and the other *Heterotanais anomalus*, Sars. He has not found any true dimorphism in the males of any of the Tanaidæ. The distinction between *Leptochelia Savignyi* and *Leptochelia dubia* is itself open to some doubt. M. E. Chevreux has sent me specimens from Villefranche, the males of which have gnathopods, such as Kröyer attributes to the *Edwardsii* and Sars to the *Savignyi* form, that is, with the teeth on the thumb very wide apart, but on the other hand they have the first antennæ, such as Sars attributes to the *dubia* form, with a curve at the base of the first joint, and with a flagellum, not indeed of nine joints, but of eight. These antennæ agree with Kröyer's description of *Edwardsii* and also with the figure and description by Bate and Westwood, so that, unless Sars has himself for once made a confusion, the males of *dubia* and *Savignyi* would seem to be undistinguishable in regard to the first antennæ, not necessarily at every stage of existence, but at some stage. Since the marital Tanaid frequently sacrifices his mouth-organs to the enormous development of his chelipeds, he must, as Norman observes, either reacquire his feeding apparatus at a subsequent moult, or else die of inanition. The alternation of form in the same individual is not improbable. It is, of course, quite distinct from dimorphism. To *Heterotanais* Sars assigns the American species *Leptochelia limicola*, Harger, and the New Zealand *Paratanais tenuis*, Thomson, and with *Heterotanais Örstedi* (Kröyer) he identifies *Tanais curculio*, Kröyer, ♂, *Tanais balticus*, Fritz Müller, ♀, and *Tanais rhynchites*, Fritz Müller, ♂. The species which Bate and Westwood call *Paratanais forcipatus* (Lilljeborg) should be named *Paratanais Batei*, Sars, and their *Paratanais rigidus* has now become *Leptognathia rigida* (Bate and Westwood). *Leptognathia laticaudata*, Sars, has been recently taken in the Clyde, and *Leptognathia Lilljeborgi*, Stebbing, is found in North Devon. The deep-sea species, *Alaotanais* (or *Neotanais*) *serratispinosus* and *Alaotanais* (or

Neotanais) lævispinosus and *Strongylura arctophylax*, all of Norman and Stebbing, taken off the coast of Ireland, may be regarded as British. The last, however, is not very markedly distinct from the Norwegian species, *Strongylura cylindrata*, Sars. The Australian species, *Paratanais linearis*, Haswell, should perhaps be transferred to *Anarthrura*, hitherto represented only by *Anarthrura simplex*, Sars, from Norway.

There are difficulties connected with the study of the Tanaidæ, owing to the differences that often exist between the two sexes, to the likenesses that sometimes exist between the females of different species, and to the prevailing minuteness of size, which descends even to one-twentieth of an inch. That many of the genera are blind is readily to be explained in connection with their habit of living ensconced in the sand. When their little white or pellucid bodies are discerned amidst the fragments of crystal, shells, polyzoa, foraminifera, and spines of urchins, it is seen that these components of the sand often exceed the Tanaids in size. It is not unlikely, therefore, that many of the species have been frequently overlooked, and that in the future those already known will be discovered in many fresh localities, and that many fresh species will eventually be brought to light.

There is a still pending dispute whether the Tanaidæ should maintain their position among the Isopoda or be transferred to the Amphipoda, or be separated from both and raised to the dignity of an independent sub-order. Of these plans the least advisable seems to be that which would mix them up with the Amphipoda, for that enormous group is at present separated from all other Crustacea by characters of the branchial organs and the pleon, in which the Tanaidæ have no share, while the Tanaidæ, on their side, have characters of the mouth-organs foreign to all the Amphipoda. The form and position of the heart, extending in the Tanaidæ from the first to the last segment of the peræon, very nearly as in the Amphipod *Corophium*, and the other resemblances in the circulatory apparatus of the two groups, pointed out by M. Yves Delage, afford the

most important argument for the proposed alliance between them. But the position of the heart, when considered in connection with the branchial arrangements, points rather in the direction of the Cumacea than the Amphipoda, and although in the Isopoda the heart is usually in the pleon, there are various genera in which it extends more or less into the peræon, thus establishing a gradation to the Tanaids in which it is wholly there. From the point of view of embryology, Bate and Westwood say of *Tanais* and *Apseudes* that 'the development is after the manner of the Amphipoda rather than that of the Isopoda,' but in point of fact, though the curvature of the embryo in the egg is inward as in the Amphipoda, the young leave the mother's pouch with the last peræopods undeveloped, as is customary with the Isopoda.

CHAPTER XXII

TRIBE II.—FLABELLIFERA

THE name refers to the circumstance that in all the members of this tribe the terminal segment in conjunction with the uropods forms a caudal fan as in the Macrura, although here the telson is often not articulated, but fused with the preceding segment. The heart is situated chiefly in the pleon, only penetrating one or two of the terminal segments of the peræon. Respiration is effected by the help of pleopods acting as branchiæ.

The families included are the Anthuridæ, Gnathiidæ, Cymothoidæ, Serolidæ, Sphæromidæ, and Limnoriidæ. The term Cymothoidæ is used comprehensively for a closely connected group of families, as will be explained hereafter.

Family 1.—*Anthuridæ.*

The body is long and narrow, subcylindrical or depressed. The head is usually shorter than the following segment. The peræon has its seven segments distinct. The first five segments of the pleon may be all distinct or completely or partially coalesced; the sixth is sometimes fused with the linguiform telson. The mouth-organs are suctorial. The first gnathopods are usually the larger, subchelate; the second gnathopods and first peræopods resembling them in general form. The other peræopods are ambulatory. There appear to be no separate marsupial plates. The first pleopods are large, commonly expanded to cover the rest. The uropods have a two-jointed inner branch, and the one-jointed outer branch usually so articulated as to arch more or less over the back of the telson.

Some eight genera are included in this family. The first four to be mentioned agree in having two rounded lobes to the lower lip, the mandibles with a cutting edge of two or three blunt teeth and a sort of semicircular saw in place of molar and spine-row, the 'palp' three-jointed; the first maxillæ are simple, with apical teeth, without 'palp;' the second are slightly cleft at the apex; the maxillipeds have from three to six broad flattened joints including the basal piece.

Anthūra, Leach, 1814, has the flagella of both pairs of antennæ few-jointed in the female, of the first multi-articulate in the male; the maxillipeds three-jointed; the first five pleon-segments fused in the female, partially distinct in the male. The telson is not coalesced with the preceding segment.

Cyathūra, Norman and Stebbing, 1886, has the flagella of both antennæ rudimentary, of the first perhaps not greatly developed in the male; the maxillipeds four-jointed; the first five pleon-segments fused, at least dorsally, in the female.

Anthelūra, Norman and Stebbing, 1886, has the flagella of both antennæ multiarticulate, of the first pair brush-like in the male; the maxillipeds six-jointed; the pleon-segments distinct, and the telson in the type-species separate from the sixth segment.

Hyssūra, Norman and Stebbing, 1886, has the flagella of both antennæ multiarticulate; the maxillipeds six-jointed; the seventh segment of the peræon seemingly devoid of limbs; the first five pleon-segments distinct, fully half as long as broad; the pleopods alike, the first pair not covering any of the following; the uropods with the outer branch long and narrow, not arching over the narrow lanceolate telson. The animal is vermiform.

Eisothistos, Haswell, 1884, has both antennæ very short in both sexes with few-(8-6) jointed flagella; the first gnathopods not subchelate, smaller than the following limbs; the first five pleon-segments short but distinct; the first pleopods covering the rest; the uropods with outer branch narrow, not arching over the broad quadrate

telson. The animal, especially the male, is vermiform. The mouth-organs have not been described. Mr. Haswell speaks of the outer branch of the uropods as 'an appendage which is directly articulated with the posterior border of the segment,' a very strange peculiarity.

Haliophasma, Haswell, 1880, would seem to be a synonym of *Anthura*, since the species *Haliophasma maculata*, Haswell, has been described by Chilton under the name *Anthura affinis*, and stated by him to be a true *Anthura*.

Ptilanthura, Harger, 1878, is probably also a synonym of *Anthura*, the one-jointed mandibular 'palp' being due, it may be supposed, to a defect of the specimen observed.

The next two genera agree in having the lower lip bipartite but acuminate; the mandibles without teeth, lancet-like, lobes at the base forming a channel for the liquid drawn by the thrust of the lancets; the first maxillæ spear-like, distally channelled and serrate; the maxillipeds elongate, consisting of four or five joints, the second of which is elongate.

Paranthura, Bate and Westwood, 1866. The flagellum of the first antennæ in the male forms a large multiarticulate brush, in the second it is rudimentary. The mandibular 'palp' is three-jointed. The pleon has six segments and the telson distinct. The outer branch of the uropods is short, variable in width.

Calathūra, Norman and Stebbing, 1886. The antennæ of both pairs in both sexes have many-jointed flagella, that of the first pair perhaps not greatly developed in the male. The pleon has six segments and the telson distinct. The outer branch of the uropods is short and wide, overarching.

Crurĕgens, Chilton, 1882. Both pairs of antennæ are short, few-jointed. The second pair have a small exopod. There is no mandibular 'palp,' but otherwise the mouth-organs bear a general resemblance to those of the two preceding genera. The seventh segment of the peræon is very short and devoid of limbs. The pleon has six segments and the telson distinct. The outer branch of the uropods is narrow, not overarching the squamiform telson.

Anthura gracilis (Montagu) was first found on the coast of South Devon. *Anthura tenuis* (Harger) is a closely allied species found in the United States. The New Zealand species *Anthura flagellata*, Chilton, was included in the genus with hesitation, owing to the misdescription in the 'History of the British Sessile-eyed Crustacea,' in which the uropods are said to be attached to the fifth instead of the sixth segment of the pleon. *Paranthura Costana*, Bate and Westwood, should be called *Paranthura nigropunctata* (Lucas). '*Anthura gracilis*,' Milne-Edwards, though agreeing with this species in the shape of the telson, has the first five segments of the pleon fused as in *Anthura*. *Calathura brachiata* (Stimpson) has been traced 'from the east coast of America, across the Atlantic, between Shetland and Faroe, off Norway, Scotland, and Ireland, and between the south of England and the Bay of Biscay.' It has been taken as deep down as 1,360 fathoms. It is well marked by a dorsal impression on the fourth, fifth, and sixth segments of the peræon, and by the great size, attaining a length of one inch and an eighth. It is the largest known species of the family.

Cyathura carinata (Kröyer) has been described under various names from the coasts of the United States, and from Denmark, but not hitherto from any part of Great Britain.

Anthelura abyssorum, Norman and Stebbing, dredged by the *Valorous*, justifies its name by the depth of 1,750 fathoms from which it was obtained near the entrance of Davis Strait. *Hyssura producta*, of the same authors, refers in the generic name to the spear-shaped telson and in the specific to the linear form of the animal. Many of the generic names in this family refer to the peculiar cup-shaped or calyx-like arrangement of the caudal fan. *Cruregens*, 'leg-wanting,' alludes to the retention of a larval character in the absence of the last pair of peræopods. *Cruregens fontanus*, Chilton, is the only known species in this family that is not marine. Mr. Charles Chilton obtained it from a well of fresh water at Eyreton in New Zealand, together with four other new subterra-

nean species of sessile-eyed Crustaceans. *Eisothistos*, 'the thrust-in one,' has for its type-species *Eisothistos vermiformis*, Haswell, obtained from about low-water mark at

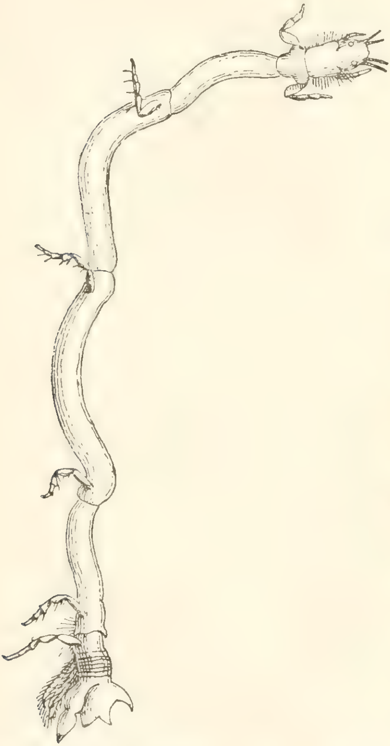


FIG. 28.—*Eisothistos vermiformis*, Haswell, the male [Haswell].

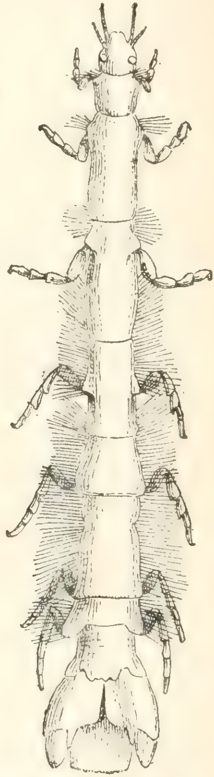


FIG. 29.—*Eisothistos vermiformis*, Haswell, the female [Haswell].

Watson's Bay in Australia. It is not a little remarkable for the shape assumed by the male, but still more for the habitation which it adopts. It occupies the tube of a *Vermilia*, one of the Serpulidæ, and with the policy of the wolf in the story of 'Little Red Ridinghood,' it not only

occupies the tenement, but puts on the guise of the original tenant. 'The whole appearance of the animal is singularly like that of a small *Serpula*, the operculum and branchiæ being mimicked by the expanded posterior appendages and telson, and the hairs representing the parapodial setæ, while the smallness of the limbs and the vermiform shape of the body, aid in perfecting the resemblance.' It is a sufficiently curious instance of mimicry that the head of one animal should be imitated by the tail of another. The creature's habit of entering the tube head foremost is quite in accord with its diminutive antennæ and abnormally small front limbs, and that when not in quest of food it should have the branchial appendages of the tail near the aperture of its cave is an obviously convenient arrangement. Probably the British *Anthura gracilis* may use a similar shelter, since it is undoubtedly dredged up in company with shells and stones on which the tubes of Serpulæ are abundant. Many of the Edriophthalma occupy tubes which they themselves construct. This is apparently the case with *Typhlotanais brachyurus*, Beddard, the tube of which is 'shaped somewhat like the shell of *Dentalium*.' The Indian Amphipod, named *Concholestes dentalii* by Dr. G. M. Giles, forms its tube within a *Dentalium* shell. It seems, however, certainly to belong to the genus *Cerapus*, other species of which have the tubes free.

Family 2.—*Gnathiidæ.*

Though the Gnathiidæ have been long contented with a single genus, the peculiarities of that genus are so great that at one time they were supposed to suffice for the institution of two separate families. There are striking differences that distinguish the sexes from one another and the adults from the young. Characters common to all are as follows. Both pairs of antennæ are short, with the flagella clearly marked off from the peduncles; the mandibles are abnormal; the first and last segments of the peræon are very small, and the last peræopods are wanting; an embryonic character permanently retained as in the genera *Hyssura* and *Cruregens* of the preceding family.

The first five segments of the pleon are distinct, carrying each a pair of pleopods; the sixth segment ends in a pointed telson and bears inserted at the sides of the base a pair of two-branched uropods resembling the pleopods except in being of a firmer texture.

In the adult male the so-called mandibles are powerful and exserted beyond the front of the quadrate head; the maxillipeds have a 'palp' consisting of four flattened ciliated joints. The first segment of the peræon is separated from the head only by a suture, and its appendages, the first gnathopods, are (in *Gnathia*) two-jointed, opercular, the first joint being a large pyriform plate fringed with setæ on the convex inner margin and containing three semitransparent calcareous plates, supposed to indicate the same number of original joints. The seventh segment of the peræon is abruptly narrower than the preceding, so that it seems to form part of the narrow pleon. The pleopods with their two one-jointed rami are sometimes ciliated, and sometimes not. Dr. Dohrn considers that the so-called mandibles of the adult male are structures that arise independently of the true mandibles as found in the young. He considers that these new structures are not concerned in feeding, but only in attaching the animal to some object. For feeding purposes he states that the opercular gnathopods are thrown open, and the maxillipeds act as whirling organs, the current of water so maintained bringing with it small nutritious particles such as do not require any powerful oral apparatus for their mastication.

In the adult female the head is subtriangular, with the eyes (when present) larger and placed further back than in the male; the mandibles are said to be wholly lost; the maxillipeds are reduced. The first gnathopods with the joints unexpanded or not much expanded lie each on a delicate membranous plate which may be marsupial. The first and last segments of the peræon and the pleon are as in the male, but the fourth, fifth, and often the sixth segments of the peræon are fused, the dilated transparent skin affording a view of the young ones within.

When the young are ready to escape, the cuticle of the mother, previously separated from the hypodermis, splits into scales on the various segments.

In the young the mouth-organs project beyond the head, and are evidently formed for piercing and for suction; the mandibles have stiliform ends, and are followed by two pairs of slender organs, which are considered to be the two pairs of maxillæ; the maxillipeds are also slender and elongate; and the first gnathopods are elongate, limb-like, with the normal seven segments; the first peræon-segment is distinct, the fourth, fifth, and sixth being perhaps fused in the young female and distinct in the young male. Dr. Dohrn considers it inappropriate to speak of the mandibles as without 'palp;' rather, he says, it is only the 'palp' which appears to be present.

It is said to be easy to keep the males alive for a year or two in a small bowl containing some of their native mud and some sea-water. As they are active climbers, precautions must be taken against their escape.

Gnathia, Leach, 1814, has long been the only genus contained in the family, to which it is entitled to give its name, as hinted by Bate and Westwood, and properly decided by the late Mr. Oscar Harger. For a long time the name *Anceus*, Risso, 1816, was used for the males, and *Praniza*, Latreille (Leach MS.), for the females and young. M. Eugène Hesse has the credit of having definitely established the relationship between the two forms, but it should not be forgotten that Leach had expressed his conviction of it as long ago as 1814. The female had already been figured and described as a marine *Oniscus* by Slabber in 1769. The best known British species is *Gnathia maxillaris* (Montagu) 1804. The 'mandibles' of the male distinguish it from the species *Gnathia Halidaii* (Bate and Westwood), instituted by those authors in 1866 with an expression of some doubt as to whether it might not be the same as *Gnathia formīca* (Hesse). The American species, *Gnathia cerīna* (Stimpson) may likewise be distinguished by the 'mandibles.' M. Hesse has described seventeen species from the coast of France, and given draw-

ings of many of them that excite some surprise by the vividness of the colouring. His *Gnathia asciaferus* has 'mandibles' of unusual shape, their axe-like appearance being alluded to in the specific name. *Gnathia stygius* (Sars) is more than half an inch long.

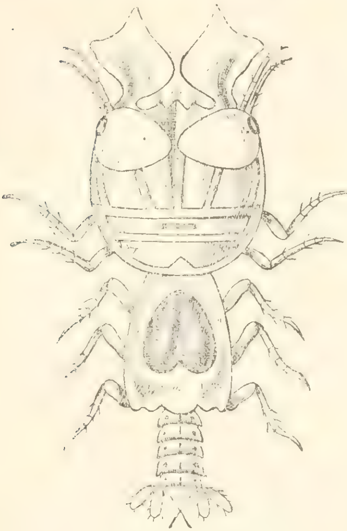
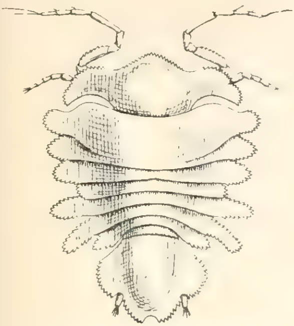


FIG. 30.—*Gnathia asciaferus* (Hesse), the male [Hesse].

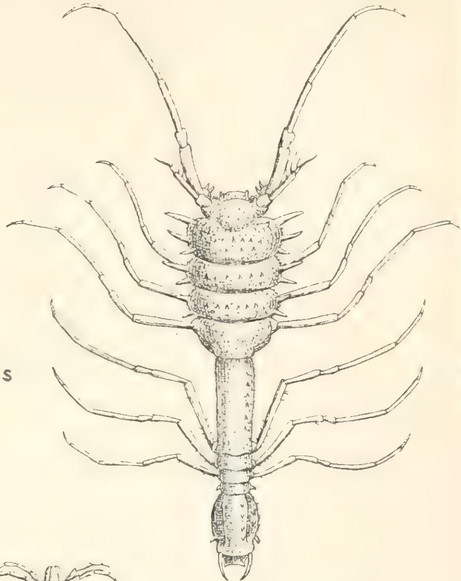
Euneognathia may be instituted as a new genus to receive the species *Anceus gigas*, Beddard, from Kerguelen. It is strikingly distinguished from *Gnathia* by having the first gnathopods in the male six-jointed. The pleopods have both branches fringed with long plumose hairs. The male of *Euneognathia gigas* (see Plate XIV.) exceeds three-fifths of an inch in length, and is therefore the largest known member of the family. The fourth and fifth segments of the peræon are markedly the widest.

Anceus bathybius, Beddard, dredged from a depth of 900 fathoms, will no doubt require to be transferred to another new genus, but the species, being founded on a fragment of a specimen, may wait for a new generic name till fuller material is obtained.

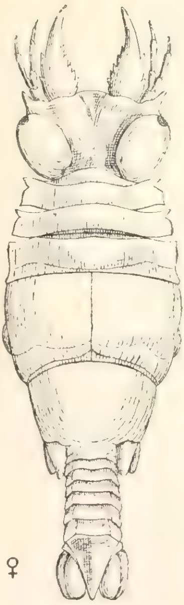
Anceus Danielii, Hesse, 1884, may also represent a distinct genus, and probably, whenever the family is monographed, it will develop as plentiful a harvest of genera as its neighbours.



Neasellus kerguelenensis



Ischnosoma spinosum



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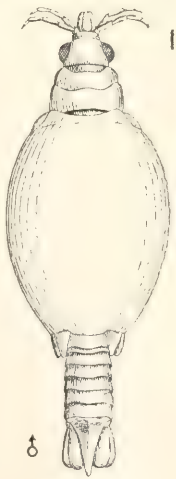
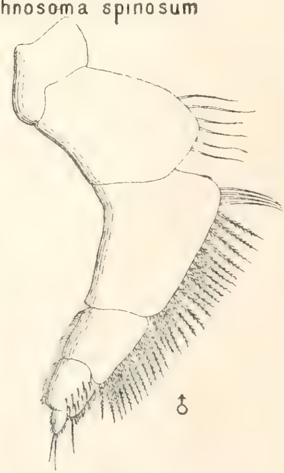
Euneognathia gigas



♂

E. gigas



♂

E. gigas. 1st Gnathopod.

Family 3.—Cymothoidæ.

In contrast with the two preceding families the Cymothoidæ, in the comprehensive sense of the term, would form a truly gigantic group. It is best, therefore, to accept the arrangement which breaks it up into at least six families, the animals in which are united in having in most cases a similar outward facies. These six families are the Cirolanidæ, Corallanidæ, Alcironidæ, Barybrotidæ, Ægidæ, and Cymothoidæ. It is common to them all to have all the segments of the peræon distinct and well developed; to have a well-developed 'palp' but no proper molar to the mandibles, the maxillipeds with the epipod short and coalesced to the underside of the head, and the plate of the second joint short or wanting; the first joint of the first gnathopods fused with the segment; the last four pairs of peræopods always longer than the three preceding pairs of limbs, and the pleopods alike in the two sexes, except for the presence of a stilet on the second pair of the male. In the young there are six pleon-segments distinct, of which the terminal one which includes the telson is large. The pleopods generally have the branches fringed with hairs, always excepting the inner branch of the fifth pair; in the first four pairs there are coupling-hooks on the broad peduncles. In the gravid female there are five pairs of marsupial plates on the first five pairs of limbs of the peræon, and small supplementary plates on the last two pairs; the maxillipeds have fringed expansions of the epipod and the first two joints, more or less covered by the front marsupial plates, and evidently designed to promote the steady influx of water upon the eggs.

Considering that in this group a father, mother, and child might in some cases readily be mistaken for specimens of three separate species, and that among the families the similarities and dissimilarities are often alike perplexing, the student has great reason to be grateful to Dr. H. J. Hansen, of Copenhagen, who in his admirable work on this subject has provided efficient clues to the labyrinth. The annexed table is translated from his treatise.

SYNOPSIS OF THE

Maxillipeds with the 'palp' free, the margins of the last two joints more or less setose, never furnished with hooks
First maxillæ with the plate of the third joint tolerably broad, at least towards the middle

- Mandibles with the distal half stout, very conspicuous, uncovered, or with only the anterior margin concealed; from the base towards the middle directed forwards and a little outwards
- Mandibles with the distal half narrow, most or all of it concealed by the upper and lower lips; from the base towards the apex directed gradually inwards

Maxillipeds with the 'palp' embracing the cone formed by the distal parts of the mouth-organs, the inner upper margin and apex never setose, the apex and sometimes the inner upper margin, at least in the males and the females without eggs, being furnished with outward curved hooks
First maxillæ with the plate of the third joint narrow throughout

- Distal parts of the mouth-organs forming a cone directed somewhat forwards
  Second maxillæ small, feeble, without hooks
  Maxillipeds with the fourth and fifth joints coalesced, forming a very long joint
- Distal parts of the mouth-organs forming a short subvertical cone
  Second maxillæ large, elongate, and proportionately broad, with two apical plates furnished with hooks
  Maxillipeds with the fourth and fifth joints sometimes coalesced, never forming a long joint

CYMOTHOID GROUP.

Mandibles with the rather broad, more or less tridentate cutting edges meeting squarely behind the large upper lip; the secondary plate and peculiar equivalent for the molar well developed First maxillæ having the plate of the first joint armed with three spines, that of the third with many Second maxillæ of moderate size, the three free plates very setose Maxillipeds with the 'palp' rather broad, very setose	Cirolanidæ
Mandibles with the distal part produced into a long prominent process, the pair much overlapping; the secondary plate and molar evanescent First maxillæ having the plate of the first joint unarmed, of the third carrying one very long spine Second maxillæ small and feeble, the free plates almost rudimentary, with few setæ Maxillipeds with the 'palp' narrowed, not very setose (the antepenultimate joint rather elongate)	Corallanidæ
First maxillæ having the plate of the first joint unarmed, of the third carrying two spines or only one Second maxillæ feeble, sometimes very small, with one plate or none, the setæ very few or none Maxillipeds with the 'palp' rather broad, with no elongate joint	Alcironidæ
. . . .	Barybrotidæ
Mandibles with the secondary plate very often (perhaps always) visible; the 'palp' with no inflated joint Maxillipeds commonly seven-jointed, sometimes four-jointed, the last joint in the latter case rather short, obtuse	Ægidæ
Mandibles with no secondary plate; the 'palp' in the adults with the first joint or both first and second joints inflated Maxillipeds always four-jointed, the last joint rather long and narrow, subacute	Cymothoidæ

The foregoing table has the special advantage of enabling a specimen in almost all cases to be referred to its proper family without dissection.

It may not be superfluous to remark that tables of this kind are not only dry and fatiguing, but to a great extent useless and unprofitable reading, until the moment comes for practical application. With specimens in hand, and possibly with all the literature relating to the specimens freely at his command, a naturalist may still be bewildered, until he lights upon the page, hitherto dull and unreadable, which briefly states the distinguishing points between several closely allied families or genera. If the characters have been skilfully chosen and clearly and accurately described, the apparently lifeless record at once becomes luminous and delightful. It will not indeed be available as a specimen of style in a book of elegant extracts, nor should it be selected as a choice morsel for public recitation; it is rather like a bank-note or a cheque, prosaic in expression, but the representative of solid value.

Family A.—Cirolanidæ.

Of the five genera grouped under this heading one may require to be transferred to an independent family.

Cirolāna, Leach, 1818, has the peduncle of the second antennæ five-jointed; the plate of the second joint of the maxillipeds furnished with hooks; the first and second pleopods alike, with at least the inner branch submembranaceous; the uropods with the inner angle of the peduncle produced.

Conilēra, Leach, 1818, has the same characters, except that the first pleopods are opercular, with both branches hard.

Eurydīce, Leach, 1815, has the peduncle of the second antennæ four-jointed; the plate of the second joint of the maxillipeds without hooks; the pleopods with both branches submembranaceous; the uropods with the inner angle of the peduncle very little produced.

Bathynŏmus, A. Milne-Edwards, 1879, is distinguished from the three preceding genera by having supplementary ramified branchiæ uniquely developed at the bases of the pleopods.

Anurŏpus, Beddard, 1886, unlike the four preceding genera, is without eyes, and the uropods have submembranaceous branches concealed beneath the telson.

The genus *Cirolana* comprehends a very large number of species. That named *Cirolana spinipes* by Bate and Westwood is identified by Hansen with the earlier *Cirolana borealis*, Lilljeborg (see Plate XV.). It is a good swimmer, tenacious of life, a savage devourer of fish, and not to be held in the human hand with impunity. Another British species, *Cirolana Cranchii*, Leach, distinguished from the preceding by the much less spinose limbs, resembles it in abundance. Upon one occasion at Anstis Cove, near Torquay, a fishing-boat drawn up on the beach was swarming with it. As the boatman had often promised to preserve any small marine curiosities met with in his fishing, his attention was called to these creatures crawling in such numbers over his boat. When asked why he had never brought any of the kind to the naturalist, his reply was that they were so common that he could not imagine any one wanting them. It is in this way that the efforts of the landsman are repeatedly baffled, unless he can fish for himself in sheltered inlets or has his breast and interior constructed of oak and triple bronze to qualify him for dredging in the open. The American *Cirolana concharum* (Stimpson) feeds sweetly on the common edible crab, otherwise called the 'blue-crab,' of the United States. From a single crab as many as a hundred and eight specimens of the *Cirolana* have been taken.

Conilera thus far is limited to a single species, *Conilera cylindracea* (Montagu), known from various parts of Great Britain, including the Channel Islands, and from the Mediterranean. Its piratical behaviour is discussed by Dr. F. Day in his remarks upon a specimen of a Dog-fish,

Acanthias vulgaris, which had been reduced to nothing but skin and bones by these parasites. They hunt, he says, in shoals, driving away the congers and other fish, but are themselves devoured by the bream. ('Proceedings of the Zoological Society, London,' for 1884, p. 44). In this and the preceding genus there is little difference between the sexes, whereas in the next that difference is sometimes, though not always, considerable.

Eurydice contains nine species, but they are not all well known. The actively swimming and viciously biting little *Eurydice pulchra*, Leach, which should perhaps rather be called *Eurydice achatus* (Slabber), is extremely common on many of the sandy shores of Great Britain. There seems a sort of conspiracy to deprive Slabber of the credit of his observations, which for his period were by no means to be despised. The specific name he chose no doubt refers to the handsome markings, which, however, are rather stellate or dendritic than agate-like, and which in this species are retained even when the animal has been preserved for many years in spirit. The eyes have a surface facetting. *Eurydice truncata*, Norman, from St. Magnus Bay, Shetland, is described as having the 'superior antennæ suddenly bent in a remarkable way at a right angle at the junction of first and second joints of the peduncle.'

Bathynŏmus has but a single species, but, in contrast with the small stature prevailing in the species of *Eurydice*, the West Indian *Bathynomus giganteus*, A. Milne-Edwards, is by far the largest of all known Isopods. The eyes are said to be placed wholly on the underside of the head, and each to contain nearly 4,000 squared facets. There is a tendency in other Cirolanidæ for the eyes to adopt something of a ventral position, so that it is not on this account necessary to place *Bathynomus* in a separate family. The development of accessory branchiæ has been no doubt necessitated by the animal's great size and its abyssal habitat, to which the specific and generic names respectively refer. Professor Milne-Edwards says that its pleopods form 'a sort of opercular system, beneath which are found the true organs of respiration, or branchiæ. These, re-

garded individually, resemble little trees or plumes, arising from stems, which, by repeated subdivision, produce a regular bush of hair.' These branchial trees are connected by their tubular stem with a network in the ordinary laminæ of the pleopods, and when the blood has been aerated it is gathered into a marginal vessel, from which it is transferred in the usual way to the cavity surrounding the heart.

Anurŏpus, with its single species, the large and remarkable *Anuropus branchiatus*, Beddard, may have greater claims to be the type of a distinct family, Anuropidæ, since, in addition to the conversion of the uropods into branchial pleopods, and the absence of eyes, the first antennæ have only two joints, and the very short 'palp' of the maxillipeds consists of a single joint.

As two of the genera of the Cirolanidæ have thirty or forty species between them, while the other three genera have only a single species apiece, it is not unreasonable to suppose that there may be many species of this family either extinct or still undiscovered. Between *Eurydice* and *Cirolana* the late M. Hesse, in 1866, places a new genus, which he variously called *Eucolumba* and *Eucolomban*, with two species named *picta* and *ornatus*.

Family B.—Corallanidæ.

Corallana, Dana, 1852, the single genus, contains some fifteen or sixteen species from the Atlantic and Pacific. The male of the species *Corallana tricornis*, Hansen, from the West Indies, is ornamented by a large frontal horn and two other large horns near the back of the head. The epithet 'large,' however, is comparative, for these horns do not approach in size the three processes of the head in *Ceratocephalus Grayanus*, Woodward, among the Sphæromidæ. Since the type-species of *Corallana*, *hirticauda*, Dana, was obtained from the coral reefs at Tongatabu, the origin of Dana's generic name cannot be misunderstood. At the same time it chimes in with the sound and composition of such names as *Cirolana*, *Conilera*, and *Rocinela*,

which Leach is said to have framed without any meaning or derivation, but simply by placing in various positions the same four consonants, and interspersing vowels to suit the requirements of his ear.

Family C.—Alcironidæ.

Under this name are grouped three or four genera in which the limbs of the peræon never show the expansion of the joints and fringing with setæ which in the preceding families often adapt those limbs to assist in the operation of swimming. The fifth segment of the pleon has its sides covered by the lateral angles of the fourth.

Alcirōna, Hansen, 1890, has the clypeus (the shield-like plate to which the upper lip is attached) large, crescent-shaped; the peduncle of the second antennæ long; the first three pairs of limbs of the peræon with the fifth joint not produced on the inner side, the last four pairs with the sixth joint not dilated. *Alcirona Krebsii* and *Alcirona insularis* are described by Hansen.

Lanocira, Hansen, 1890, has the clypeus small; the peduncle of the second antennæ short; the limbs of the peræon as in the preceding genus. *Lanocira Kröyeri*, Hansen, is the type.

Tachæa, Schiödte and Meinert, 1879, has the clypeus small; the peduncle of the second antennæ long; the first three pairs of limbs of the peræon with the fifth joint very broad, produced on the inner side, the last four pairs with the sixth joint dilated. To the type-species, *Tachæa crassipes*, Hansen adds *Tachæa incerta*.

Corilāna, Kossmann, 1880, is incompletely described, but is remarkable by having on the very short first pair of limbs the claw as long as the other joints together. The type-species, *Corilana erythræa*, is from the Red Sea, and was established from a specimen only an eighth of an inch long.

In addition to the six species of Alcironidae already mentioned, five or six more may in fact belong to this family, rather than to the genera *Æga*, *Cirolana*, and

Corallana, to which they have been assigned, but infirmities of description have made it impossible for Dr. Hansen to decide these cases. It is only by degrees beginning to be understood that by naming undecipherable species naturalists increase neither the resources of science nor their own reputation.

Family D.—Barybrotidæ.

Barybrōtes, Schiödte and Meinert, 1879, is the only genus. The limbs of the peræon have the seventh joint in the first three pairs forming a strong hook, and all the seven pairs by dilatation of the joints or garniture of setæ are auxiliary to swimming. Two species, *Indus* and *agilis*, were instituted by the authors of the genus. Hansen finds that these are one and the same, and adopts the name *agilis* as the most significant, but as *Indus* has precedence in the original authority, it should be retained. Schiödte and Meinert state that the male has a stiliform appendage on the inner side of the inner branch of the second, third, and fourth pleopods, which would be a truly remarkable feature. But Hansen, who has examined the type-specimens, declares that neither here nor in any other Isopod does such an appendage occur on the third and fourth pleopods, it being limited here as elsewhere, to the second. A noticeable feature in the species is that the seventh segment of the peræon is almost entirely concealed. The animals have only been taken in the open sea.

Family E.—Ægidæ.

To discriminate the young of this family from those of the Cymothoidæ demands careful scrutiny. It has for this purpose to be noticed that in the Ægidæ the last three pairs of peræopods have the seventh joint rather shorter than the sixth, and, though a little curved, not forming a hook, whereas in the Cymothoidæ this seventh joint is not shorter than the sixth and forms a much curved hook. When the animals are adult or half-grown the distinction is easy. In addition to the character already mentioned,

the Ægidæ have the flagella of both pairs of antennæ markedly distinct from the peduncles, and the earlier pleopods, the uropods, and the terminal segment of the pleon ciliated.

Æga, Leach, 1815. The maxillipeds have seven joints, or at the least six. In the female with eggs, the first pair of marsupial plates are so large that they cover up all the parts of the mouth except the clypeus, part of the upper lip, and about half the 'palp' of the mandible, thus leaving the animal incapable of taking food. In accordance with this condition, the ovigerous female, it is said, has never been taken upon a fish.

Rocinēla, Leach, 1818. The maxillipeds are four-jointed; the mandibles have the apex narrow, not denticulate, and the second joint of the 'palp' not much longer than the first.

Alitrŏpus, Milne-Edwards, 1840. The maxillipeds are four-jointed. It is doubtful whether this genus should be separated from *Rocinela*. The descriptions of *Alitropus typus*, Milne-Edwards, and of *Alitropus foveolatus*, Schiödte and Meinert, do not supply characters for discriminating it.

Syscēnus, Harger, 1878. The maxillipeds are four-jointed. The mandibles have the apex flattened and denticulate, and the second joint of the 'palp' shorter than the first. The type-species, *Syscenus infelix*, Harger, is without eyes.

In the 'British Sessile-eyed Crustacea,' Bate and Westwood describe four species of *Æga*. The first is called *Æga bicarinata*, Leach, which must yield to the earlier name *Æga rosacea* (Risso), a Mediterranean species, for the occurrence of which in Great Britain there is no definite authority. It is very like *Æga Strömii*, Lütken, but distinguished from it by much smaller and more widely separated eyes. It is now known that the specimen mentioned by the above-named authors as sent them by the Rev. A. M. Norman from the coast of the county of Durham, was in fact an *Æga Strömii* with eyes contiguous. The second species *Æga tridens*, Leach, has also large eyes,

which are almost contiguous, and is distinguished by the three apical teeth of the telson. The third species, *Æga psora* (Linn.), has the eyes well separated, and the inner branch of the uropods emarginate on the inner side near the apex. Because of the latter character Leach called it *emarginata*, a name that would be naturally supposed to apply to the telson, and which fortunately had to make way to an earlier name. The fourth species, *Æga monophthalma*, Johnston, is not very happily named, since there are very conspicuously two large elongate eyes, though they happen to meet apically. The terminal segment of the pleon has a central carina. It attains a length of more than two inches. That which Johnston supposed to be a variety of this species has been determined by Schiödte and Meinert to belong to *Æga Strömii*. Twenty species in all are distinguished by those authors, who point out that the genera *Pterĕlas*, Guérin, and *Ægacylla*, Dana, are synonyms of *Æga*. *Æga crenulata*, Lütken, has been recorded from Scotland. The species *Æga spongiophĭla*, Semper, is notable for making its home in the beautiful silicious sponge, *Euplectella aspergillum*, of the Philippines, in which it can scarcely be expected to live by sucking the juices of fish, but it is probably well supplied with food from the other crustaceans and small marine animals of various kinds which enter the glass-rope basket by accident or design, and find themselves entrapped within it in presence of a dangerous foe. *Æga Schioedteana*, Bovallius, was described in 1885, *Æga Lovéni*, Bovallius, in 1886.

Of *Rocinela* Schiödte and Meinert distinguish from various parts of the world nine species, the type being the British *Rocinela danmoniensis*, Leach. *Rocinela signata*, Schiödte and Meinert, is found in the West Indies and Central America. To one or other of these two species, the other seven are said by Hansen to approach very closely. He points out that both in *Æga* and *Rocinela* the structure of the maxillipeds is probably adapted to pulling apart the skin of a fish and clearing a space for the attack of the mandibles. He considers *Alitropus foveolatus* from

Bengal and Borneo a true *Rocinela*, and that the genus *Rocinela* may be regarded as a kind of link between the Ægidæ and the next family.

Family F.—Cymothoidæ.

The members of this family in their advanced stages are distinguished from the Ægidæ by the antennæ, which are nearly always strongly reduced, without clear distinction between peduncle and flagellum; by the strongly hooked fingers of the fifth, sixth, and often also of the seventh, pairs of limbs of the peræon; and by the absence of ciliation from the pleopods, from the terminal segment of the pleon, and almost always from the uropods.

By one very curious character in at least some of the genera this family is distinguished, so far as at present known, from all the other families which in its more comprehensive sense the name Cymothoidæ includes, as well as from all other Isopods. At a certain period of its life the young Cymothoid of some genera is a male, with three pairs of testes, two rudimentary ovaries internal to the testes, and a paired copulatory organ into which the two vasa deferentia open. After a subsequent shedding of the integument, and when the female glands have been developed at the expense of the gradually diminishing male glands, the now developed marsupial plates become free on the legs of the peræon, and the copulatory organs are thrown off. This strange cycle of events was discovered by Mr. J. F. Bullar, and confirmed by Dr. Paul Mayer, the latter showing that self-fertilisation does not occur. As these animals when adult adopt a parasitic mode of life, and cannot therefore roam about in quest of partners, Hansen suggests that the propagation of the species may be materially assisted by the alternation of sex in each individual. The peculiarity has been observed in the genera *Cymothoa*, *Nerocila*, and *Anilocra*. It is not to be assumed as belonging to genera in which it has not been actually remarked, and it is rash to speak of the Cymothoidæ as hermaphrodite on one page, and on another to assign to this family species of *Æga* and

Serolis as well as of *Cymothoa* and *Anilocra*, without any warning that so strange a characteristic does not necessarily or even probably appertain to all the miscellaneous assemblage. It has been suggested that something of the same kind may occur in some of the Epicaridea.

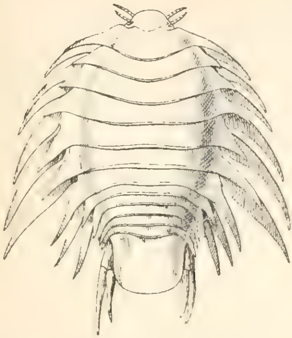
The Cymothoidæ, after the exclusion of the five families already characterised, are still a group of embarrassing size, including at least thirty genera, and about four times as many species. The description of this single family by Schiödte and Meinert occupies a volume larger than the present. Twenty of the genera are instituted by those authors. To say that they give a figure and description of every species would very inadequately express the scope of their labour. It must be added that the descriptions and figures are repeatedly double, or triple, and sometimes fourfold. This was necessary on account of the differences already alluded to between the forms assumed by the same animal at different periods of life. The symmetry of the young is often exchanged in the adult for a more or less distorted shape due to its residence, these animals being found in the mouths, and on or within the skin, and about the fins of various fishes, in the mouths of squids, and in other strange situations. It does not seem proper to follow Schiödte and Meinert in their further subdivision of this family into three families, which they name Anilocridæ, Saophridæ, and Cymothoidæ, but, whatever view may be taken on such a matter of detail, their work will be found indispensable to a student of this group. Even with all the assistance it gives he will not always find the task of identifying his specimens too easy. Under the circumstances it is useless to compress into these pages any brief synopsis of the numerous genera, although one or two of them may receive a passing mention.

Nerocīla, Leach, 1818, contains more than thirty species. The eyes, which are manifest in the larval and young forms, in the adults as a rule gradually disappear, this being obviously in connection with the assumption of a parasitic life, which led Latreille to name the genus *Ichthyophĭlus*, 'a lover of fish.' *Nerocila depressa*, Milne-

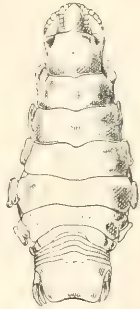
Edwards, and *Nerocila serra*, Schiödte and Meinert, in general appearance somewhat approach the next family, the Serolidæ, but this is still more the case with *Nerocila Lovéni*, Bovallius, 1887 (see Plate XV.), from the coast of Java, in which the side-plates of the peræon-segments 'are very long, extremely produced, flattened in the form of sabres or flat horns, very sharp;' those of the seventh segment reaching nearly to the end of the peduncles of the uropods. The New England species, *Nerocila munda*, Harger, is not mentioned by Schiödte and Meinert.

Livonēca, Leach, 1818, contains twelve species. The head, which is large in the young, is much smaller in the adult male, and generally of moderate size in the adult female. The eyes suffer less diminution with advancing age than in the preceding genus, with which in regard to the mouth-organs it is in near agreement. Whereas in the arrangement by Schiödte and Meinert these two genera are widely separated, Hansen regards them as closely connected, and both very near to *Rocinela*, a genus of the Ægidæ. *Livoneca Redmanni*, Leach, is a variable species, widely distributed on the east coast of North and South America; *Livoneca ovalis* (Say) is perhaps a synonym of it. As in other species of this genus the adults are usually twisted to one side.

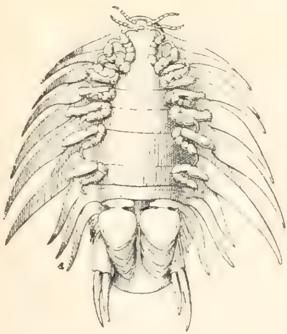
Anilocra, Leach, 1818, contains sixteen species, one of which excels in size all others of the family, this being *Anilocra gigantea* (Herklots), for which Herklots instituted the genus *Epichthys*, but without assigning any distinguishing character of any importance except the gigantic size. The length of three inches and a half, though striking even in this family of large Isopods, is not a character of generic value. It is remarked, however, that the young of this species is very different from the young of neighbouring species, even of those most nearly allied in the adult forms. *Anilocra asīlus* (Linn.), recorded by the Rev. A. M. Norman from Herm, is interesting, not merely as being hitherto the only British representative of the family, but as being the ancient *Pediculus marinus* of Rondelet and Gesner.



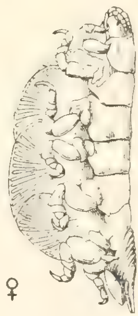
Nerocila Lovéni. *Dorsal view*



Ceratothoa auritus



N. Lovéni. *Ventral view*



♀

C. auritus

♂

C. auritus

♂

C. borealis
Mandible

Cirolana borealis

♂

C. borealis
Head

Olencira, Leach, 1818, has but one species, but that the remarkable *Olencira prægustator* (Latrobe) of America, in which the first six pairs of feet from before backwards are successively and gradually longer, but the seventh pair abruptly much so.

Ægathoa, Dana, 1852, is not mentioned by Schiödte and Meinert. The definition, Mr. Harger says, is:—'Body elongate oval; pleon not suddenly narrower than the thorax; head large, subtriangular; eyes large; legs nearly alike throughout, with strong curved dactyli; epimera of moderate size or small; pleon long and large, composed of six distinct segments; pleopoda not ciliated; uropods more or less distinctly ciliated, rami subequal.' Mr. Harger remarks that the large granulated eyes remind one of *Æga*, and that the ciliated uropods also indicate the approximation of this genus to the preceding family. The ciliation is, however, nearly rudimentary in the New England species, *Ægathōa loliginea*, Harger.

Lobothōrax, Bleeker, 1857, is distinguished by the strong dorsal carination along the first four segments of the peræon, and the deep sinuation in the centre of their hinder margin. The species are *Lobothorax typus*, Bleeker, from Batavia, and *Lobothorax aurītus*, (Schiödte and Meinert) from the Philippines. From what must be considered a fanciful objection to the formation of the name *Lobothorax*, the latter authors thought proper to change it into *Saophra*, which they made the leading genus of their family Saophridæ.

[*Glossobīus*], Schiödte and Meinert, 1883, is notable for the great disparity in size between the male and female. Of *Glossobius linearis* (Dana) the two often quoted authors give five descriptions relating to the adult male and female and to three stages of the young. The ovigerous female attains a length of an inch and a half, while the adult male is content with about two-fifths of an inch at the largest. The generic name signifies 'tongue-life,' and the species mentioned infests several kinds of flying-fish in a way that justifies the name. 'The female embraces the fish's tongue, perforating its lower conjunctive membrane with the very

large and curved third pair of claws, and, while with its ventral surface it covers the top of the tongue, it projects beyond the apex of it with its first pair of feet, so that the mouth of the fish can hardly be closed. The male, as usual, many times smaller than the female, is often found covered by her tail and ventral surface.' Though this species appears to be confined to the Atlantic, *Glossobius laticauda* (Milne-Edwards) pays the same amiable attentions to the flying-fishes of the Pacific, and *Glossobius auritus*, Bovallius (see Ceratothoa auritus, Plate XV.), is reported both from the Atlantic and the 'Indian Seas.'

Ceratothŏa, Dana, 1852, includes twelve species, in some of which the male is very much smaller than the female. *Ceratothoa Banksii* (Leach) is identified with the *Pediculus marinus* of Seba. Miers finds that it is also the same as the *Oniscus imbricatus*, Fabricius, the type of which is in the British Museum from the collection of Sir Joseph Banks. The name *Banksii* is therefore superseded by *imbricatus*. Hansen notes as a singular circumstance that in the second stage of the young of this species the fifth pleopods carry hooks, which are absent from that pair in the adults of this whole group. *Ceratothoa crassa*, Dana, is, according to Dr. Bovallius, a *Glossobius*. It is worth remarking that, though the genus *Ceratothoa* is accepted as Dana's, he is not cited as an authority for a single one of the accepted species. On the other hand, his *Ceratothoa linearis* is transferred to *Glossobius*, and his *Ceratothoa crassa* by Schiödte and Meinert is called *Glossobius laticauda* (Milne-Edwards), and by Bovallius *Glossobius crassus* (Dana). It would appear, therefore, that *Glossobius* is really a synonym of *Ceratothoa*, and that a new generic name is required for the species that have been assigned to *Ceratothoa*. For this purpose *Meinertia* may be fitly proposed.

Cymothoa, Fabricius, 1793, still has seventeen species, after the successive restrictions to which it has been subjected. Of *Cymothoa eremīta* (Brünnich) the Copenhagen Museum has specimens still adhering to the tongues of the fishes on which they were originally taken, showing that

this species agrees in its habits with those of the so-called *Glossobius* *Cymothoa œstrum* (Linn.) is also often taken on the tongues of fishes. It is said to have been once found within the shell of *Strombus gigas*. It is reckoned 'among the largest and noblest of the family of the Cymothoæ.'

Ichthyoxĕnus, Herklots, 1870, means 'an enemy of fish.' This is more plain speaking than Latreille's *Ichthyophĭlus*, but the treatment to which these genera expose the fish is the same, whether spoken of as love or hate. *Ichthyoxenus Jellinghausii*, Herklots, excavates in the under side of *Pontius* (*Barbodes*) *maculatus*, Bleeker, behind the ventral fins, a deep hole wherein the male and female live together. The fish is found in the river Tjikerang, in the kingdom of Bandong in Java. The two parasites, lodged in the invagination of the outer wall of the fish's abdomen, become too large when adult to be able to pass through the orifice of their cell. MM. Giard and Bonnier suggest that two larvæ enter together, and that one of them having the more favourable position continues its evolution beyond the male stage and becomes the female partner. A second species, *Ichthyoxenus montanus*, Schiödte and Meinert, comes from a fish taken in the streams of the Himalayan mountains.

Ourozeuktes, Milne-Edwards, 1840, contains three species, all from Australia, the original *Owenii*, Milne-Edwards, and *monacanthi* and *caudatus*, established by Schiödte and Meinert. In this genus the segments of the pleon, though distinguishable, are fused together, and that part of the animal is greatly narrowed, whereas the peræon is for the most part very broad. By the widening of some of the joints the hinder legs, especially the last pair, assume a very curious appearance.

Harpŏnyx pranizoides, Sars, 1882, a new genus and species founded on two specimens each a quarter of an inch long, is referred rather vaguely to the family of the Cymothoidæ, without explanation of the limits assigned to that family. The long second antennæ suggest that the animals are not fully adult, though they are too well deve-

loped to be regarded as larval forms. It is very singular that they are devoid of the last pair of peræopods. Apart from this extremely distinctive feature it might be supposed that the species belonged to the genus *Olencira*, with the somewhat variable type-species of which it agrees in having a very small 'palp' to the maxillipeds, the hinder legs very elongate, with long curved nails, and the pleon narrow, with a subtriangular termination. It differs in having no eyes.

Codonophĭlus, Haswell, 1881, is placed by its author among the Cymothoidæ, in Dana's subfamily Ægathoinæ, and the type-species, *Codonophilus argus*, Haswell, is said to approach *Ægathoa*, Dana. The mandibles have the 'palp' elongate. The maxillipeds are small, operculiform, three-jointed, the small basal joint probably not being reckoned in. The uropods have a single ramus which is falciform and carries a few scattered cilia. By the single ramus of the uropods this genus would seem to approach the family Sphæromidæ.

Family 4.—Serolidæ.

The body is strongly depressed; the broad head is united, with or without a suture, to the first segment of the still broader peræon. The seventh segment of the peræon is without side-plates, this and sometimes also the sixth being dorsally fused with the pleon with or without suture; ventrally also these two segments are more or less closely united. The side-plates of the sixth segment are the longest. The pleon consists of three small free segments and a large terminal composite one. The pair of eyes are rarely absent. The second pair of antennæ are not greatly longer than the first. The powerful mandibles have a three-jointed 'palp;' the five-jointed maxillipeds form an operculum over the two delicate pairs of maxillæ. The first gnathopods are subchelate. The second are similar to the first in the male, except that they are smaller, but in the female they are similar to the following peræopods. The last peræopods are smaller than any

of the six preceding pairs of limbs. The first three pairs of pleopods are natatory, the fourth and fifth branchial. The uropods are lateral, and comparatively small. The marsupium consists of four pairs of plates, formed probably, as in the Gnathiidæ, by the separation of the ventral cuticle from the hypodermis.

In strong contrast with the preceding family the present contains but a single genus. This, however, is a strikingly well-marked type, which has excited unusual interest by an external resemblance to the extinct Trilobites. It is disappointing that, except in the general shape of the body and to a certain extent in the character of the eyes, nothing has been found to substantiate any close relationship between the two groups. A similarity in their habits is probable, but that might account for general resemblance apart from relationship. Professor Studer says of the Serolidæ that they 'live by preference on sandy ground, into which they burrow with their flat bodies up to the caudal plate. Their nourishment appears chiefly to consist of the organic materials distributed in the fine sand, diatomacea and organic detritus. Their locomotion is carried on less by swimming than by backward movements on the sandy ground, wherein the widely separated feet are used as the point of support.' The male is often but not invariably larger than the female. In grasping his partner by the front rim of the carapace with the claws of his second gnathopods, he sometimes, according to Studer, drives his over-affectionate nails through the tender chitinous integument of his beloved.

Serolis, Leach, 1818, now contains, besides five doubtful species, seventeen that are well ascertained, nine of which were instituted by Mr. F. E. Beddard in his Report on the Isopoda of the *Challenger*. The first gnathopods have the sixth joint or hand fringed with very peculiar spines of two kinds. The type-species is *Serolis paradoxa* (Fabricius), at first named *Oniscus paradoxus* by Fabricius in 1775, and afterwards transferred by him to his genus *Cymothoa*. In 1833 Eights described *Brongniartia trilobitoides*, from Patagonia. By Milne-Edwards and Audouin

this was removed from the fossil genus and twice renamed as *Serolis Brongniartiana* and as *Serolis trilobitoides*. Beddard considers it to be perhaps the same as Studer's *Serolis cornuta* from the Crozets and Kerguelen. The distribution of the genus is rather peculiar, for though the type, first reported from Tierra del Fuego, is said by Leach to occur also on the coast of Senegal, and *Serolis carinata*, Lockington, has been recently described from California, all the other species belong to the Southern hemisphere. The shallow-water species do not even extend north of latitude 30° S., and though some of the deep-water species approach the equator, none of them pass to the north of it. *Serolis neæra*, Beddard, was dredged up from a depth of 2,040 fathoms, and *Serolis Bromleyana*, v. Willemoes Suhm, from the slightly smaller depth of 1,975 fathoms. The latter somewhat exceeds the former species in size, and is the largest in the genus. The male is more than two inches long and more than two inches broad, and, if the length is reckoned not along the central line but from the rostrum to the end of the greatly produced sixth side-plate, it exceeds three inches. All the deep-sea species except *Serolis antarctica*, Beddard, agree in having these side-plates greatly produced, especially in the male. The Australian *Serolis minuta*, Beddard, only a sixth of an inch in length and in breadth, is the smallest species known. Five other species belonging to Australia form a connected group, in which the dorsal portion of the sixth peraeon-segment is extremely narrow, and that of the seventh is either absent or fused with the first of the pleon. In these characters they agree only with *Serolis minuta*, and are separated from that by having the side-plates of the pleon undeveloped. These Australian species are named *australiensis*, *elongata*, *pallida*, *longicaudata*, by Beddard, accompanying the earlier *tuberculata* of Grube. The island of Kerguelen, so richly supplied with sessile-eyed Crustacea, has three species, *Serolis cornuta*, Studer, *Serolis septemcarinata*, Miers, and *Serolis latifrons*, White.

Mr. Beddard finds that the deep-sea species are distinguished in an important manner from those of shallow

water by the character of the eyes. 'The results,' he says, 'of my investigations into the minute structure of the eye in *Serolis* may be briefly summed up as follows:—(1) The shallow-water species invariably possess well-developed eyes which are fundamentally similar to those of other Isopoda, but differ in several particulars; the retinulæ are composed of only four cells; the rhabdom is often a highly complicated structure unlike that of other Crustacea. Another element unrepresented (?) in the eyes of other Crustacea is present, consisting of two large hyaline nucleated cells placed below the rhabdom and between the retinal cells. (2) In the deep-sea species the eyes are either altogether absent (*Serolis antarctica*), or, if present, show signs of structural degeneration; no retinula, at least nothing comparable to the retinula in the eyes of the shallow-water species, is present, but the vitreous body is represented. The vitreous bodies may be enclosed in a sheath of pigment (*Serolis neæra*), or there may be no pigment present (*Serolis gracilis*, *Serolis Bromleyana*).'

From examination of the contents of the stomachs Mr. Beddard has come to the conclusion that these interesting Crustaceans are upon occasion cannibals.

Family 5.—Sphæromidæ.

The body is convex, the head transverse; the pleon is vaulted over the pleopods, its earlier segments, exclusive or inclusive of the first, being usually fused into a short segment marked more or less by sutural lines, the terminal segment being, on the other hand, very large. The eyes are generally wide apart; both pairs of antennæ have the flagellum multiarticulate and well marked off from the peduncle. The mandibles have a three-jointed 'palp;' the first maxillæ have two plates, the second three; the maxillipeds are seven-jointed, the second joint being produced into a plate. The limbs of the peræon are slender, generally with bifid fingers. The first three pairs of pleopods are ciliated, with the outer branches not opercular; the second pair in the male have a stilet on the inner

branch. The uropods are affixed near the base of the terminal segments, and have not more than one branch that is movably articulated.

The family is at present in a state of considerable confusion. Genera and species have been established on characters which, it has since been ascertained, are, at least in some instances, only marks of age or sex. In recent years various suggestions have been made for cancelling several of the genera so established, but without any effective investigation to determine whether there may not be valid distinctions to take the place of those which have proved inappropriate. In the very erudite and comprehensive work on the Crustacea by Gerstaecker, now in course of publication in Germany, the reduction of genera has been carried far beyond what will, I think, be found eventually tenable. In several of the genera the character that has attracted earnest attention has been some dorsal spine developed, now on one, now on another part of the animal. As a rule, it now appears that these outgrowths belong to the male, and not to the female, but the attempt to refuse them all generic value on this account is not likely to be successful.

Sphærōma, Latreille (in Bosc), 1802, has the body usually contractile into a sphere, as implied by the name; the telson is without any apical incision. Neither pair of antennæ is elongate; the mandibles have a dentate cutting-edge and strong molar; the first maxillæ have denticulate spines on the outer plate; the maxillipeds have the 'palp' strongly ciliated. The limbs of the peræon are all ambulatory, not powerful, but with short and thick fingers. The upper or outer branch of the fourth and fifth pleopods is thin and laminar, acting as an operculum to the pleated branchial inner branch. The outer branch in these and sometimes also in the third pair is unequally divided by a suture. The free outer branch of the uropods is subequal to the prolongation of the peduncle which represents the inner branch. The species are numerous, but not all well ascertained. Of the British species, *Sphæroma serratum* (Fabricius) is occasionally found on the shore in large

groups. The specific name refers to the serrate margin of the movable branch of the uropods. *Sphæroma curtum*, Leach, is common among seaweeds on the coast of Devon, but isolated rather than in groups. *Sphæroma Prideauxianum*, Leach, may be regarded as a synonym of the preceding, founded on large specimens. *Sphæroma rugicauda*, Leach, is distributed over the coasts of England, Scotland, and Ireland, frequently where the water is not very saline, as, for instance, at Barnstaple in North Devon. The stilets of the second pleopods in the male are very elongate, apically widened and rounded. *Sphæroma Hookeri*, Leach, is very similar to the preceding species, but distinguished by two small longitudinal ridges on the pleon. Both species have been taken in company on the coast of Sussex.

Zuzara, Leach, 1818, was established for species differing from *Sphæroma* by having the outer branch of the uropods larger than the fixed inner one, and concave above instead of flat. The species also have the sixth segment of the peræon dorsally produced.

Næsa, Leach, 1818 (*Nesæa*, Leach, 1814, preoccupied), has the sixth segment of the peræon larger than the others, and produced backwards in a bidentate process. The uropods are affixed not at the base, but near the further end, of the terminal segment, and, while the fixed inner branch is directed transversely inward, the movable outer one extends backwards beyond the end of the segment. In the British species *Næsa bidentata* (Adams), the pleon is rugose with two dorsal tubercles and a terminal excavation. Bate and Westwood suggest that this species may prove to be the male of *Dynamene Montagui*, Leach, in which there are two dorsal tubercles on the sixth segment of the peræon and two on the pleon. It seems not improbable that the species named *Dynamene rubra* and *Dynamene viridis* by Leach, and *Campecopea versicolor* by Rathke, may represent the female, and *Dynamene Montagui* the young male, of *Næsa bidentata*. These forms are all found on British coasts under similar conditions and with the same variations of colour—green, or red, or variously mottled; but

the *Dynamene* forms have the pleon not rugose and the uropods fixed some way up the terminal segment, and the branches not in any marked manner extending beyond it, nor separated from one another. The forms *rubra* and *viridis* are also without dorsal tubercles. No one appears to have ever found the *Næsa* form or *Dynamene Montagui* carrying eggs, and, as they are not at all uncommon, they may, therefore, be presumed to be of the male sex. The differences between the female *Dynamene* and *Næsa* in the hinder half of the animal are superficially very great, but they are bridged over to a certain extent by the intermediate form of *Dynamene Montagui*. All the three forms agree in having both branches of the fourth and fifth pleopods furnished with transverse folds or pleats so as to be fully branchial. *Dynamene* in 1814 had as yet no species.

Cymodoce, Leach, 1814. It is not easy to understand why authors have combined not only to adopt a different form of this name, but to base the alteration on Leach's original authority. In this genus the pleon is dorsally tuberculate, with two apical notches, and the outer branch of the uropods so placed that it cannot completely close under the inner, both branches remaining always salient. The British species are *Cymodoce truncata*, Leach, and *Cymodoce emarginata*, Leach, the latter of which has not recently been found. *Cymodoce Lamarckii*, Leach, from Sicily, is briefly described, and not in agreement with the generic definition. M. Eugène Hesse has persuaded himself, not only that *Dynamene* is the female of *Næsa*, which is possible, but that *Sphæroma* is the female of *Cymodoce*, which certainly cannot be accepted on such arguments as he produces. As between British species assigned to the two genera, there is no resemblance of colouring worth speaking of, and no community of residence, except that *Cymodoce* is occasionally and very rarely found on some of the shores that also yield *Sphæroma*. In *Sphæroma quadridentatum*, Say, Mr. Harger has ascertained that neither sex is a *Cymodoce*. The curious fact remains that no ovigerous *Cymodoce* has yet been recorded. It is, perhaps, still more singular that the sexual characters in this group

should have been so little examined, that their relationships are left rather to speculative argument than to any basis of observed facts. I can, however, myself testify that *Sphæroma rugicauda*, Leach, need not have recourse to *Cymodoce* for a male form. In the character of the pleopods *Cymodoce* agrees with *Sphæroma* as opposed to *Næsa*, although, as to the stilets of the second pair, in *Cymodoce truncata* they are apically narrowed.

The species, *Cymodoce abyssorum*, Beddard, from 1,070 fathoms, off New Guinea, must be transferred to a new genus, for which I propose the name *Næsicopea*. The last segment of the peræon is much narrower than the segment before or the segment behind it, and has the side-plates rudimentary. There are two median dorsal teeth, one behind the other, on the pleon. The fourth and fifth pleopods have both branches fully branchial. The uropods in the male have the inner branch rudimentary, the outer greatly prolonged. In the female they are placed higher up than in the male, with a longer inner branch, and the outer not much longer than the inner. The name refers to the combination of characters found in *Næsa* and in the genus next to be mentioned.

Campecopea, Leach, 1814, has the sixth segment of the peræon produced in the male, but not in the female. The uropods are inserted high up on the terminal segment, and have the movable branch, long, curved, and produced beyond the apex of the segment; while the inner branch, marked off by a partial suture from the peduncle, is a mere knob, only distinguishable on the under side. It can scarcely be doubted that only one British species of this genus is at present known, *Campecopea hirsuta* (Montagu), of which *Campecopea Cranchii*, Leach, is the female. The two forms are constantly found in company in the little blackish or dark green sea-weed, *Lichina pygmæa*. In colour they entirely agree, as in almost all other particulars except the long tooth on the sixth peræon-segment. In some specimens this tooth may be seen in various stages of growth, while others are entirely without it. All specimens roll themselves up very tightly, so that, in

spite of the projecting uropods and even of the peræon-process, they roll about with great facility. The projections from the body promote their resemblance to the weed among which they live. *Campecopea lineata*, Hesse, taken 'under stones, near Brest,' seems to be the same species.

Cilicæa, Leach, 1818, has the front or median part of the pleon dorsally produced into a long spine in the male, but not in the female. The apex of the pleon is notched as in *Cymodoce*.

Cycloidūra, Stebbing, 1878 (*Cyclura*, Stebbing, 1874, preoccupied), has the pleon wider than the preceding part of the animal, a peculiarity which it shares with very few of the Isopoda. The large oval branches of the uropods are of unusually thin texture, and are very salient, the movable outer branch folding only partially beneath the fixed inner one. The Australian type-species, *Cycloidura venosa*, has the seventh segment of the peræon produced into a large dorsal spine, at least in the male. A new genus near to *Cycloidura* may be required for the Californian species, *Sphæroma amplicauda*, Stimpson.

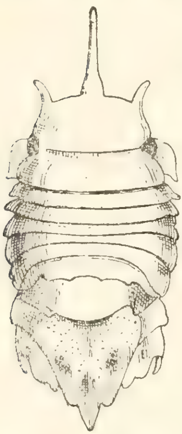


Fig. 31. — *Ceratocephalus Grayanus*, Woodward [Haswell].

Isoclădus, Miers, 1876, rather closely resembles the preceding genus, but has the uropods 'subequal, of a slightly sigmoid shape, and acute at the extremity.' The spine of the seventh peræon-segment is not developed in the female. The species, *armatus* (Milne-Edwards) and *spiniger* (Dana), are from New Zealand.

Ceratocephălus, Woodward, 1877, has the head produced in the male into three large processes of which the central is much the longest. In the female 'faintly marked projections' take the place of the processes. The terminal segment of the pleon is produced in an obtusely pointed process beyond the uropods, which are affixed high up on the sides of the segment, and have the outer movable branch

quite minute. The second antennæ are unusually elongate. It is probable that *Bregmocerella tricornis*, Haswell, from Port Jackson, is specifically as well as generically identical with *Ceratocephalus Grayanus*, Woodward, from Bass's Strait, although the figures given differ in some particulars.

Circeis, Milne-Edwards, 1840. The head and body are comparatively elongate, the segments of the peræon little flexible; the first antennæ have a very large basal joint, with the second joint embedded in its apical emargination; the uropods have the outer branch longer than the inner. Both the species are southern, and their names *tridentata* and *bidentata* refer to the apical notching of the pleon.

Amphoroidea, Milne-Edwards, 1840, has the first joint of the first antennæ greatly dilated; the first segment of the pleon distinct but rudimentary; both the branches of the fourth and fifth pairs of pleopods transversely fluted for branchial purposes. The type-species, *Amphoroidea typa*, from Chili, seen from above and by help of the projecting first joints of the upper antennæ, has the outline of a jar or amphora. Dana names a second species *australiensis*. G. M. Thomson describes *Amphoroidea falcifer*, from New Zealand, but thinks it may be identical with one or other of the two species just mentioned.

Cassidina, Milne-Edwards, 1840, has the body greatly dilated beyond the insertions of the slender legs. The uropods do not reach the narrow apex of the terminal segment, and have the outer movable branch much smaller than the fixed inner one. *Cassidina typa*, Milne-Edwards, is only a third of an inch long. The species *latistylis*, Dana, is said by Miers to be a synonym of *emarginata*, Guérin-Méneville. This, according to Studer, reaches a length of an inch and a quarter and a breadth of more than four-fifths of an inch in the male, though the female, which is a little over an inch in length, is only two-fifths of an inch broad. Studer describes a third species, *Cassidina maculata*, which, like *emarginata*, is found at Kerguelen Island, and G. M. Thomson describes a fourth species, *Cassidina neo-zealanica*, from New Zealand.

Haswellia, Miers, 1884 (a new name for the preoccupied *Calyptūra*, Haswell, 1881), has the last segment of the peræon produced into a broad plate or shield over and beyond the pleon. The pleon has a terminal quadrangular notch, with a squarish lobe within it. The first antennæ are broad at the base. The type is *Haswellia carnea* (Haswell).

Ancinus, Milne-Edwards, 1840, has the body flattened, the pleon triangular with a truncate tip; the eyes dorsal instead of lateral; the first and second gnathopods subchelate with long curved fingers; the uropods with only one branch, which is long and narrow, and, as in *Næsa* and *Campecopea*, does not hug the telson. The single species, *Ancinus depressus* (Leach), exhibits considerable diversity in the forms of the limbs of the peræon.

Scutuloidea, Chilton, 1882, has the body not very convex, the peræon much broader than the head, the pleon broadly triangular, emarginate at the apex, and the uropods contiguous to it, very salient, single-branched, consisting of a large squamiform plate. The type is *Scutuloidea maculata*, Chilton, from New Zealand. The second gnathopods are longer than the other limbs of the peræon.

Plakarthrium, Chilton, 1882, has the body much depressed, with the side-plates of the peræon greatly expanded, the first pair produced forward at the sides of the head, and the seventh pair backwards nearly to the extremity of the uropods. The two basal joints of the first antennæ and the third and fourth joints of the second are expanded, enclosing all the front of the head. The pleon is rectangular, with the uropods sub-terminal, the outer branch short, apically dilated. *Plakarthium typicum*, Chilton, found on the seaweed *Eklonia radiata*, in Lyttelton Harbour, New Zealand, 'affords a very good example of protective resemblance, for the body being very flat and of a brown colour can scarcely be distinguished from the seaweed, to which it closely adheres.' Its position among the Sphæromidæ is somewhat doubtful, if it be the case

that the mandibles have no 'palp' or only a one-jointed one. By the antennal joints projecting in front, the uropods extended behind, and the large side-plates of the peræon radiating laterally and distally widened, the head, the back of the peræon, and the pleon are completely enclosed, and the outline becomes an unbroken oval. The animal, being only one-fifth of an inch long, might, like the still smaller *Campecopea hirsuta*, seem to be no fit subject for protective mimicry. It must be supposed that, minute as they are, they are found worth eating by creatures highly enough organised to be guided in their attacks by form and colour.

Family 6.—Limnoriidæ.

The body is sub-depressed; the pleon has six distinct segments. The eyes are lateral, wide apart; the antennæ of both pairs are short, the first having a single-jointed flagellum; the mandibles have a chisel-like cutting edge, the molar tubercle obsolete, the 'palp' small, three- (or perhaps sometimes two-) jointed; the first maxillæ have two slender plates, the second have three; in the maxillipeds the second joint is produced, the five joints of the 'palp' are short, its three middle ones somewhat expanded; the epipod is elongate; all the limbs of the peræon are similar, not prehensile, but with bifid fingers; the five pairs of branchial pleopods are sheltered in the vaulted pleon, all ciliated except the fifth pair, which is smaller than the rest; the second pair in the male have the usual stilets; the uropods have two single-jointed branches, both movable, the outer much shorter than the inner.

Limnoria, Leach, 1814, is the only genus. The type, *Limnoria lignorum* (J. Rathke, 1799), known at Plymouth as the Gribble, has an evil fame for gnawing submerged timber. It is widely distributed. Inaccuracies in the earlier descriptions of the species have been pointed out by the late Mr. Oscar Harger with his accustomed care and acuteness. In New Zealand Mr. C. Chilton has found a second species, *Limnoria segnis*, on the roots of the sea-

weed *Macrocystis*, not burrowing into wood. He believes that the 'palp' of the mandible is only two-jointed. The epipod of the maxillipeds is much larger than in *Limnoria lignorum*, and is apically widened instead of having an acute apex.

CHAPTER XXIII

TRIBE III.—VALVIFERA

HERE the uropods undergo a remarkable metamorphosis, and assume a function distinct from any that they have elsewhere, for like a pair of folding doors they form a great part of the ventral surface of the pleon, these valves closing over the five pairs of branchial pleopods or opening to admit the water to them.

In the 'History of the British Sessile-eyed Crustacea,' vol. ii. pp. 358, 368, 375, 378, the uropods are successively spoken of as 'the first or anterior pair of pleopoda,' as pertaining to 'the first segment of the tail,' as being absent in the Idoteidæ, where there is said to be a 'conversion of the fifth pair of pleopoda into a continuous operculum for the protection of the branchial organs,' and lastly, in the genus *Idotea*, as 'a strong outer pair (which are the terminal uropoda), forming an operculum' over the 'five pairs of very delicate branchial appendages.' Of these four statements the first two are consistent but erroneous, the last two are inconsistent with the first and with one another; only the final one is correct. All the four, as it happens, appeared in the same number of the work, namely, Part 19, published October 1, 1867, so that the confusion is difficult to account for, even as an accident of dual authorship.

The tribe includes two well-separated families, the Arcturidæ and Idoteidæ.

Family 1.—*Arcturidæ.*

The form of the animal is elongate and sometimes cylindrical; the segments of the pleon are more or less

coalesced. The second antennæ are large and long; the mandibles have a molar tubercle but no 'palp;' the outer plate of the first maxillæ and the inner plate of the second are broad; the maxillipeds have an oval epipod, a broadly expanded plate to the second joint, and the five joints of the 'palp' not very large; the first four pairs of limbs of the peræon are directed forwards, slender, ciliated, with the terminal joint minute; the last three pairs are stouter, ambulatory, with the terminal joint bifid. The opercular uropods have the inner branch much shorter than the peduncle, the outer branch rudimentary or sometimes entirely wanting. When the valves are closed the branch of the uropods which is homologically the outer is shut up inside, even when present.

Arctūrus, Latreille, 1804, has the flagellum of the second antennæ more than four-jointed, the fourth segment of the peræon not greatly longer than the others, the marsupium of the female composed of four pairs of plates. The arctic *Arcturus Baffini* (Sabine) grows to a length of three inches. Mr. F. E. Beddard has described thirteen new species brought from various parts of the world by the *Challenger*. Others have been described by Miers, Sars, and Studer. Almost all have a striking appearance from the armature of spines or tubercles. In their clinging habit and general appearance they have some resemblance to the amphipod group, the Caprellidæ, some of which are also very spinose. It is interesting to observe that in creatures which are structurally very distinct a similar mode of life goes with a similar general appearance, so that the similarity of life may be supposed to have produced the similarity of look.

Astacilla, Cordiner, 1795 (=*Leacia*, Johnston, 1825), has the flagellum of the second antennæ not more than four-jointed, the fourth segment of the peræon much longer than any of the others, and the marsupium of the female consisting of two plates affixed to this segment. There is no reason for discarding Johnston's *Leacia*, on the ground that the different name *Leachia* was preoccupied. It is a common and quite justifiable practice to form generic names by

variations on the same theme, as *Darwinia* and *Darwinella*. Harger points out that Fleming's reference of *Astacilla* to the Rev. Charles Cordiner, 1784, is no proof that it was published or described at that date. But in a work entitled 'Remarkable Ruins and Romantic Prospects of North Britain with Ancient Monuments and Singular Subjects of Natural History by the Rev. Charles Cordiner of Banff. London, 1795,' there is a section headed 'Astacillæ, Purple Doris, &c.,' containing the interesting passage which follows :—

'One very lively species of little lobsters, which had taken up their dwelling among these coralines, seemed on account of its novelty to merit the attention of a particular drawing.

'Their general form and appearance in their natural state, and the size of life, are carefully represented at *a*, *a*, *a*; an elaborate delineation of the microscope, after a minute investigation of the particular structure of its several parts, is inserted above at A. That will more distinctly express to the curious the peculiarities of the animal than any specific distinctions which could be narrated. The eye appeared as a regular arrangement of bright specks, in circular rows, as at the figure I.

'The diminutive ASTACILLÆ, of the general name of lobsters, is applied at present, as a common characteristic, until one more particularly appropriate may be fixed on to distinguish it by; for these are a species that do not appear to have been yet recognized among the varieties of British insects.'

Seeing that this account is accompanied by an unmistakable figure of *Astacilla longicornis* (Sowerby), it seems only proper to uphold the priority of Cordiner's generic name, and perhaps the name of the family ought to become Astacillidæ. The British species are *Astacilla longicornis* (Sowerby), *Astacilla intermedia* (Goodsir), *Astacilla gracilis* (Goodsir), *Astacilla damnoniensis*, Stebbing, *Astacilla Deshayesii* (Lucas), and *Astacilla dilatata*, Sars. This last and others of the genus named by the same author are found on the coasts of Norway. *Astacilla granulata*, Sars,

occurs in the North Atlantic, *Astacilla marionis*, Beddard, in the Southern Ocean. The young of this genus sometimes, if not always, have the fourth segment of the peræon not elongate, just as in *Arcturus*.

Family 2.—Idoteidæ.

The body is ovate or oblong, or more or less oblong-ovate. The mouth-organs and pleon and its appendages are nearly as in the preceding family, but the maxillipeds sometimes have the 'palp' become three-jointed by coalescence. The second antennæ are not as a rule greatly elongate; the flagellum may be rudimentary, single-jointed, or more usually multiarticulate. The limbs of the peræon are usually nearly alike, but the first three pairs are sometimes subchelate, and the last two may be 'multiarticulate.'

Glyptonōtus, Eights, 1852, has the maxilliped-'palp' three-jointed, the two terminal joints being fused and also the two that precede them. The first three pairs of limbs of the peræon have the sixth joint dilated and are subchelate. The pleon has three or four complete sutures; the stilets on the second pair of pleopods in the male are very elongate; the outer branch of the uropods is minute. *Glyptonotus antarcticus*, Eights, being '*dorsally sculptured*,' corresponds with the generic name. It attains a length of three inches and a half by a breadth of an inch and three-quarters, and is, therefore, one of the monster Isopods. The Arctic species, which also occurs in the Baltic and the depths of the Swedish Lakes, *Glyptonotus entomon* (Linn.), is not much smaller than the preceding. *Chiridotea*, Harger, 1878, is regarded by Miers as a synonym of *Glyptonotus*.

Chætilia, Dana, 1852. Mr. Miers, in his elaborate 'Revision of the Idoteidæ,' says:—'The multiarticulate character of the sixth and seventh thoracic legs is probably not a character of the importance assigned to it by Dana. In its ovate form, four-segmented postabdomen [pleon], and elongated antennules, the relationship of *Chætilia* to *Glyp-*

tonotus is obvious; but the antennules in *Chætilia* are placed immediately above the antennæ, as in *Edotia*.' In *Chætilia ovata*, Dana, the sixth pair of legs are described as being 'twice as long as the entire animal, terminating in a very long bristle-like extremity, which consists of numerous joints The seventh pair has also a multiarticulate extremity, which is, however, quite short.' Dana thought a separate family Chætiliidæ necessary for this genus.

Arcturides, Studer, 1882, in general appearance and in the length of the second antennæ approaches *Arcturus*, but the short-jointed limbs are all very nearly alike, though the first are shortest, and the three following pairs a little more prehensile than those to the rear. In the southern *Arcturides cornutus*, Studer, the head has a pair of frontal horns, and is not articulated with the first peræon-segment though divided from it by a suture.

Idotea, Fabricius, 1798, has the second antennæ moderately elongate; the maxilliped-'palp' four-jointed, only the last two joints being fused; the limbs of the peræon all nearly alike, with the sixth joint not or not much expanded, but the seventh prehensile. The uropods have on the basal plates a raised line near and almost parallel to the inner margin, and an apical plumose seta, which is concealed under the terminal plate. The species are very numerous, and several additional genera have been proposed which Mr. Miers does not think worthy to be upheld.

Idotea marina (Linn.) is the name he adopts for that which Bate and Westwood describe as *Idotea tricuspidata*, Desmarest, and *Idotea pelagica*, Leach, and which has also been called by a dozen other names. It is very abundant. Its distribution appears to be almost cosmopolitan. In size and colour it is extremely variable. *Idotea metallica*, Bosc, which seems to have as great a range over the world, is, however, not recorded from British coasts. *Idotea emarginata*, Fabricius, is common in British waters, but not like *marina* on the shore, and the same may be said of *Idotea linearis* (Linn.), with which Mr. Miers combines the curiously striped *Idotea sexlineata* of Kröyer.

Idotea lacustris, Thomson, from New Zealand, can make itself at home in fresh water. It has been taken by Mr. Chilton in Mihiwaka Creek, a mountain stream, at 200 feet or more above the sea-level. The young leave the marsupium with all the segments developed and their appendages present, but the second antennæ having a single-jointed instead of a multiarticulate flagellum.

Idotea prismatica (Risso) belongs to a section in which the pleon is composed of four or five instead of only three more or less distinct segments, and in which the species are small, with a few-jointed flagellum to the second antennæ. It has a small outer branch to the uropods. It is found in North and South Devon, and has been described by Bate and Westwood as *Idotea parallela*. It is a question whether a separate genus ought not to be named for the group of species to which it belongs. *Zenobia*, Risso, 1826, in which it was originally placed, is a preoccupied name.

Idotea acuminata (Leach) belongs to a section in which all the segments of the pleon are dorsally fused and form a single piece. In *Idotea appendiculata* (Risso) it has a synonym, the two different forms of pleon being connected by numerous gradations. The species is found in North and South Devon, and in the Clyde as well as in the Mediterranean. For the group to which it belongs perhaps the genus *Leptosōma*, Risso, 1826, should be upheld, with a substitute for the name which again is preoccupied. Miers includes in this group the Australian *Crabyzos longicaudatus*, Spence Bate, 1863, although in that species the head is fused with the first segment of the peræon.

Edotia, Guérin-Méneville, 1829–44, has the body rather convex, and the pleon one- or two-jointed. The second antennæ are either short with an obsolete or rudimentary flagellum, or well developed. The limbs of the peræon have the seventh joint strong, the sixth joint in the first three pairs not greatly dilated. The uropods have the basal plates crossed by an oblique line. The Arctic *Edotia bicuspida* (Owen) is beautifully coloured. It has the second antennæ well developed. *Edotia trilōba* (Say)

is an instance of the group in which the flagellum of the second antennæ is rudimentary. Sars remarks that in his opinion 'Harger's genus *Synidotea* [1878] should for the present be retained for the two Arctic species *S. bicuspida* and *S. nodulosa* [(Kröyer)], both differing distinctly from the form described by Guérin-Méneville—*Edotia tuberculata*—in the well-developed, multiarticulate flagellum on the second pair of antennæ.'

Cleantis, Dana, 1849, is distinguished by the flagellum of the second antennæ being all fused into a single piece, but even this character is sometimes shared by *Idotea prismatica.* The pleon in *Cleantis* may consist either of one, two, three, or five distinct segments. The New Zealand species, *Cleantis tubicola*, Thomson, is eleven times as long as it is broad. Mr. Chilton is disposed to regard it as normally not a tube-dweller, though the type-specimen was found in a tube. The species with all the segments of the pleon fused, such as *Cleantis filiformis* (Say) from the United States, were referred by Dana and Harger to a separate genus, *Erichsonia*, Dana, 1849.

On this family the work by Miers already mentioned and Harger's 'Report on the Marine Isopoda of New England and adjacent waters' are essential to the student for the groundwork of his inquiries.

CHAPTER XXIV

TRIBE IV.—ASELLOTA

THE second pair of antennæ are elongate; the maxillipeds are furnished with an epipod, have the second joint produced into a plate, and the 'palp' consisting of five distinct joints. The first pleopods in the female are usually transformed into a single opercular plate, and in the male are variously modified; the four following pairs are branchial; the uropods are terminal, or, if lateral, not remote from the apex of the pleon, one- or two-branched, or consisting of a single joint. There are two families, the Asellidæ and Munnopsidæ.

Family 1.—*Asellidæ.*

The mandibles have a denticulate cutting edge, a molar tubercle, and usually a three-jointed 'palp.' The limbs of the peræon are prehensile or ambulatory, not specially modified for swimming. The marsupial pouch is formed of plates pertaining to the first four, or to the second, third, and fourth segments of the peræon. Some twenty-five genera are included in this family, many of them exhibiting very striking peculiarities.

Asellus, Geoffroy, 1762, shares with *Mancasellus* a character exceptional in the tribe to which it has given its name, in that the pleon in both sexes has the first pair of pleopods quite small, consisting in the female of two unjointed oval plates, while the second pair are opercular, but not fused together in either sex. The female has but four, the male has five pairs of pleopods. The heart extends from the pleon through the peræon. This genus belongs exclusively to fresh water. *Asellus aquaticus*

(Linn.) is a species distributed almost all over Europe in great abundance. The details of its organisation, external and internal, are explained, with a clearness of language and drawing which leaves nothing to be desired, in the 'Histoire naturelle des Crustacés d'eau douce de Norvège' by G. O. Sars, 1867. M. Dollfus says that *aquaticus* is completely displaced in Palestine by his new species, *Asellus coxalis*. Harger mentions *Asellus communis*, Say, as common in the fresh-water ponds and streams of New England. For other species, and the bibliography of the genus, the 'Notes on the Family Asellidæ,' by Dr. Bovallius, should be consulted.

Mancasellus, Harger, 1876, was named to take the place of *Asellopsis*, Harger, 1874, preoccupied. This genus is exceptional in regard to the mandibles which have no 'palp,' being otherwise very like *Asellus*. *Mancasellus tenax* (S. I. Smith) and *Mancasellus brachyurus*, Harger, are found in the fresh waters of North America.

Cæcidotea, Packard, 1871, is without eyes, has the seventh joint of the limbs not bifid, and the uropods elongate, with two unequal branches. The species *Cæcidotea stygia* is found in the Mammoth and Wyandotte Caves and in wells in Indiana. The absence of eyes does not distinguish it from *Asellus*, for some of the species of that genus are also blind.

Janīra, Leach, 1814, is a marine genus, dorsally not unlike *Asellus*, but the second antennæ have a small scale or exopod; the first limbs of the peræon have the sixth joint scarcely expanded; the first pleopods in the female form a subcircular operculum. The uropods are two-branched. The only British species is *Janira maculosa*, Leach. In regard to the American species, *Janira alta* (Stimpson), Harger says of the pleopods in the male:—'The thickened opercular plates are three in number, viz., a pair of semi-oval plates at the sides, and a more slender median plate presenting traces of a suture along the middle.' This formation is probably characteristic of the genus, and no doubt, as explained by Hansen for *Eurycope*, the fused plates represent the first pleopods, and the semi-oval plates

the second pleopods. *Ianthe speciosa*, Bovallius, is by Hansen identified both generically and specifically with the earlier *Janira spinosa*, Harger. *Janira abyssicŏla*, Beddard, was obtained among the Fiji Islands, from a depth of 1,350 fathoms; *Janira laciniata*, Sars, from 400 fathoms on the west coast of Norway. *Janira tricornis* (Kröyer) comes from Greenland.

Trichopleon, Beddard, 1886, has a rudimentary exopod on the second antennæ, the limbs of the peræon with the seventh joint simple, the uropods with the outer branch one-jointed, the inner two-jointed. The type is *Trichopleon ramosum* from the Philippines.

Iathrippa, Bovallius, 1886, was instituted to receive the New Zealand species, *Janira longicauda*, Chilton, the genus being distinguished from *Janira* chiefly by the two branches of the uropods being long, laminar, and lanceolate, instead of narrow and stiliform.

Iais, Bovallius, 1886, is distinguished by having the terminal joint of the limbs 'triunguiculate.' It has two elongate laminar branches to the uropods. The type is *Iais Hargeri* from the Strait of Magellan.

[*Acanthoniscus*], Sars, 1879, differs from *Janira* in having 'the first legs not subchelate, the rest with the seventh joint simple, and the uropods stiliform with very short branches.' The type species, *Acanthoniscus typhlops*, is blind. Dr. Bovallius having pointed out that the name *Acanthoniscus* is preoccupied, it may be changed to *Acanthaspidia*.

Ianthopsis, Beddard, 1886, was instituted to receive *Ianthe Bovallii*, Studer, from Kerguelen. It is allied to the preceding genus, but distinguished from it by having eyes, a rudimentary flagellum to the first antennæ, and bifid fingers on the limbs of the peræon. All the limbs are similar to each other in both sexes. The uropods have a long peduncle and two branches, of which the inner is the larger.

Iolanthe, Beddard, 1886, is described as most nearly allied to the two preceding genera. It has no eyes, and the lateral margins of the head and the segments of the

peræon are prolonged into long curved spiny processes. To save research into classical authorities for the origin of the name of this genus, it may be mentioned that it was taken from the title-rôle of a popular comic operetta by Gilbert and Sullivan.

Jæra, Leach, 1814, is distinguished from many of the preceding genera by its shorter second antennæ, shorter limbs, and especially by the uropods, which are very short and have two diminutive branches. There are two British species, *Jæra albifrons*, Leach, and *Jæra Nordmanni* (Rathke), both very small. The former, which is rather the larger, has a very extensive northern distribution. Both are often at home in runlets of fresh water traversing sea-beaches. *Jæra Guernei*, Dollfus, is an inland river species of the Azores.

Jæropsis, Koehler, 1885, is distinguished from *Jæra* by its very small pairs of antennæ, its narrow peræon with the segments laterally set apart, and other particulars. The type, *Jæropsis brevicornis*, was taken at Sark. All the species are minute. *Jæropsis marionis*, Beddard, is founded on a specimen less than a sixth of an inch long. The length of *Jæropsis neo-zelanica*, Chilton, is about a tenth of an inch.

Jamna, Bovallius, 1886, was instituted to receive *Jæra longicornis*, Lucas, from Algeria, in which the first limbs are chelate, and the uropods are two-branched, with the branches longer than the peduncles.

Stenetrium, Haswell, 1881, has the second antennæ long, and carrying an exopod. The first limbs are chelate or nearly so. The terminal joint is bifid in the following pairs. The uropods are two-branched, the branches narrow. Haswell describes *Stenetrium armatum* and *Stenetrium inerme* from Australia, Chilton, *Stenetrium fractum* from New Zealand, Beddard, *Stenetrium Haswelli*, from South America.

Munna, Kröyer, 1839, has the head large, the pleon fused into a single segment; the eyes extremely prominent, the second antennæ very long, with their bases below the short first pair. The limbs of the peræon of the first pair

are short, robust, and subprehensile, of the following pairs ambulatory, very long, with the seventh joint bifid. The anterior pleopods are arranged as in *Janira*. The uropods are minute, seemingly single-jointed. Two British species have been described, *Munna Kröyeri*, Goodsir, and *Munna Whiteana*, Bate and Westwood, but Sars decides that the former is male, the latter female, of one and the same species, so that the name *Whiteana* must be cancelled. The type is *Munna Boeckii*, Kröyer. The species are very small, and the differences such as are not always very easy to seize when exhibited on so minute a scale. There are three other Norwegian species, *Munna Fabricii*, Kröyer, *Munna limicŏla*, Sars, and *Munna palmata*, Lilljeborg, the last distinguished by its enormously developed first pair of feet. Of the *Munna Fabricii*, Sars remarks that Kröyer himself mixed up several species in his description and figures under this name. Beddard describes two species from Kerguelen, *Munna pallida* and *Munna maculata*. Chilton describes *Munna neozelanica* from New Zealand, a species in which the first gnathopods of the adult male have a very remarkable form, with the second joint small, the third 'very thick and strong, hollowed anteriorly to receive the distal end of the limb when bent back; carpus expanding distally, mallet-shaped; propodos small and rounded.'

Paramunna, Sars, 1866, has exceedingly prominent eyes, the mandibular 'palp' short and thick, three-jointed, the last three segments of the peræon narrow and armed with acute lateral processes. The uropods are very short, simple, biarticulate. The genus is intermediate between *Munna* and *Pleurogonium*. The type, *Paramunna bilobata*, has the head divided in front into two truncate lobes. It is a sixteenth of an inch long.

Pleurogonium, Sars, 1871, is a change of name from *Pleuracantha*, Sars, 1864, said to be preoccupied. It has some or all of the segments of the peræon laterally spiniferous, the anterior four being also acuminate. The pleon forms a single piece constricted at the base with the apex obtusely pointed. There are no eyes. The mandibles

have no molar tubercle, and the 'palp' is very small, indistinctly two-jointed. The limbs are nearly as in *Munna*. The uropods are very short, two-branched, the branches simple, unequal. The Norwegian species are *rubicundum*, *spinosissimum*, and *inerme*, all instituted by Sars. Beddard has added two species from Kerguelen and one from Tristan da Cunha.

Acanthomunna, Beddard, 1886, is akin to *Munna*, but the first antennæ have a long instead of a short flagellum, and the limbs of the peræon have the seventh joint simple. The type is *Acanthomunna proteus* from New Zealand.

Leptaspidia, Bate and Westwood, 1867, has not been very fully described. The animal is said to be 'pear-shaped, flattened,' but the latter epithet does not well apply to the ovigerous female. The pleon is oval, entire and almost acute at the apex. The limbs, except the first pair, are very slender, but not very short; they have the seventh joint simple. The uropods are minute, single-jointed, lateral. The first pleopods are said to 'shut together in the form of a flattened pear, divided down the centre.' The impression given by the figure is of a pair of valves as in the tribe valvifera. This may be correct in regard to the male, but in the female there is a single opercular plate, slightly carinate down the centre. The type is *Leptaspidia brevipes*, from the Clyde, where this microscopic species was first found by Mr. David Robertson in the strange fibrous nests of the mollusc *Lima hians*. It has no eyes.

Neasellus, Beddard, 1885, is near to *Pleurogonium* and *Paramunna* in character, and in the articulation of the first antennæ below the lateral extension of the head it recalls the appearance of *Leptaspidia*. The first and second segments of the peræon are dorsally fused in the middle; the fourth and seventh segments are narrower than their neighbours. The type is *Neasellus kerguelenensis* (see Plate XIV.).

Astrūrus, Beddard, 1886, is much like *Leptaspidia* and *Pleurogonium* in appearance. There appear to be traces of eyes. The fingers are not bifid. The uropods are rudimentary, yet perhaps two-jointed. The type is *Astrurus crucicauda* from the prolific vicinity of Kerguelen.

Nannoniscus, Sars, 1869, has the head produced into a frontal process, the pleon consisting of a single piece, subtriangular, apically rounded or truncate. There are no eyes. The mandibles have ten spines in the spine-row, the molar short and narrow, the 'palp' short, three-jointed. The operculum of the pleon is short, armed with a tooth; the uropods are very short, two-branched, with the inner branch the longer, or they are single-branched. The type, *Nannoniscus oblongus*, Sars, a twelfth of an inch long, was taken at depths between 120 and 250 fathoms. It is described as having on the short three-jointed first antennæ 'a single ovoid olfactory papilla of portentous size.' A second species, *Nannoniscus bicuspis*, Sars, has the first antennæ seven-jointed, the second pair forming on the outer side a large triangular process. This species has the uropods simple, biarticulate.

Eugerda, Meinert, 1890, has the last three segments of the peræon longer than the anterior segments, the pleon-segments fused into one. The mandibles are without molar and 'palp.' The maxillipeds have the first three joints of the 'palp' broad, the last two narrow and small. All the limbs of the peræon are long, the first pair more slender and smooth than the rest. The opercular plate of the pleon is orbicular; the uropods are moderately long, the branches single-jointed, the inner the longer. *Eugerda globiceps* is the type.

Dendrotion, Sars, 1871, has the head divided into two ear-like branches, to which the two pairs of antennæ are attached. The first four segments of the peræon have each a long spine on either side; the three following segments are abruptly much narrower. The pleon has all the segments fused into one. There are no eyes. The mandibles have a conical molar, the 'palp' three-jointed, The first limbs of the peræon are shorter than the others, which are long and slender. There are no uropods.

Macrostylis, Sars, 1864, has the first three segments of the peræon so closely united as to give an appearance of fusion, the four following segments being very distinct, with acute postero-lateral angles. The pleon forms a long

segment, dilated in the middle and ending obtusely. The first antennæ are short, the second long, with the flagellum shorter than the peduncle. The mandibles are without 'palp;' the maxillipeds have the two terminal joints of the 'palp' very short. The third pair of limbs of the peræon are the most robust, while the fourth pair are very small, and the seventh not much larger. The uropods are long, slender, simple, two-jointed. The type is the Norwegian *Macrostylis spinigera*, from a specimen about a sixteenth of an inch long. *Macrostylis latifrons*, Beddard, from 2,050 fathoms in the North Pacific, is a fifth of an inch long. *Vana longiremis*, Meinert, 1890, beyond doubt agrees generically and probably also specifically with the type of *Macrostylis*.

Ischnosōma, Sars, 1866, meaning 'a slender body,' is, perhaps, the most singular-looking of this family. The fourth and fifth segments of the peræon are fused, and combine to form a columnar centre to the animal. The pleon is constricted at the base. There are no eyes. The mandibles have a large molar, but no 'palp.' The first limbs of the peræon are short and robust, the others slender and long. The uropods have a single one-jointed branch. The type is the Norwegian species, *Ischnosoma bispinosum*, Sars. The same author has described an Arctic species, *Ischnosoma quadrispinosum*. Beddard adds *Ischnosoma spinosum* (see Plate XIV.), from the Azores, *Ischnosoma bacillus*, from 50° south latitude, *Ischnosoma bacilloides*, from South America, and *Ischnosoma Thomsoni*, from 2,050 fathoms depth in the North Pacific.

Family 2.—Munnopsidæ.

The animal has a bipartite appearance, the anterior portion consisting of the head and first four segments of the peræon, the last three segments of the peræon and the consolidated pleon forming the other. There are no eyes. The first limbs of the peræon are subprehensile and shorter than the three following pairs of limbs, which are ambulatory and in general very elongate; the next two or the next three pairs are natatory, having some of the joints

flattened and ciliated. The incubatory pouch in the female is generally under the first four segments of the peræon.

The swimming joints above described resemble those found on some of the swimming crabs, and differ strikingly from what is customary among the Isopoda. To this family, indeed, the title of equal-legged animals is singularly inappropriate.

Munnopsis, Michael Sars, 1861, has the body suddenly constricted and slender behind the fourth peræon-segment. The second antennæ are very elongate, with the peduncle six-jointed. The mandibles are acuminate, with a secondary plate on the left, but not on the right mandible, without molar, and with a three-jointed 'palp.' The first and second limbs of the peræon are short, rather robust, subprehensile, the two following pairs enormously elongated; the three following pairs are natatory, without a seventh joint. The arrangement of the pleopods corresponds with that already described in *Janira*. The uropods are slender, single-branched. *Munnopsis typica*, Michael Sars, the type-species, has a very extended boreal distribution in deep water on muddy ground. Hansen says that in the second antennæ the long fourth and fifth joints of the peduncle are immovably fused. In these organs the flagellum is nearly as long as the peduncle, and the two together are about five times the length of the body. By the great elongation of the fifth and sixth joints in the third and fourth limbs these equal about three times the body's length. *Munnopsis australis*, Beddard, with no 'palp' to the mandibles, and with the marsupium arising apparently only from one segment of the peræon, must probably be referred to a separate genus.

Eurycōpe, Sars, 1864, has the body not abruptly constricted. The second antennæ are very elongate, with six-jointed peduncle. The mandibles have a spine-row, molar, and three-jointed 'palp,' but no secondary plate on either mandible. The first pair of limbs are rather short, the next three pairs are long, and the last three pairs are natatory, with an unguiform seventh joint. The pleopods are as in the preceding genus. The uropods are short,

two-branched, the branches single-jointed. Eight Norwegian species have been described by G. O. Sars, in some of which the second, third, and fourth limbs are extremely elongate, but in *Eurycope robusta*, Harger, from the Gulf of St. Lawrence, they are not much longer than the body. The three species first described, *Eurycope cornuta*, *phalangium*, and *mutica*, all of Sars, range in length between a seventh and a sixteenth of an inch. *Eurycope gigantea*, Sars, extensively distributed in the high north, attains a length of an inch and a third, by a breadth of over half an inch. It is notable that this species and *Munnopsis typica* appear invariably to occur together. Both sexes are known of both. The first antennæ are shorter in the females than in the males. In *Eurycope gigantea* there is, according to Hansen, a little triangular plate on the third joint of the second antennæ, which may be regarded as a rudimentary exopod. It would not seem very rash to conclude from this that the first two joints are really one joint subdivided. The fourth

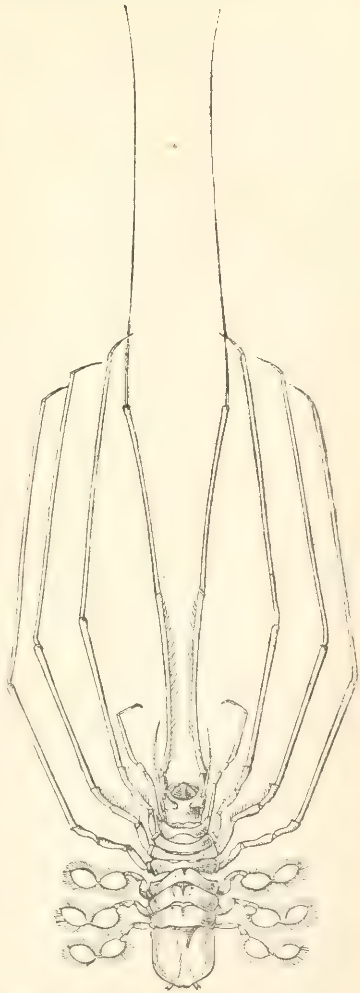


FIG. 32.—*Eurycope gigantea*, Sars [Hansen].

and fifth joints are, Hansen says, in this species firmly fused. Of the swimming-feet he observes that the feathered setæ are attached a little within the margin, to obtain support when displayed for swimming, and to have a resting-place when folded away between the strokes. Eight new species are named and described by Beddard from the *Challenger* explorations, all from considerable and some from very great depths.

Ilyarachna, Sars, 1869, 'mud-spider,' was named in place of the preoccupied *Mesostĕnus*, Sars, 1864, meaning 'narrow in the middle.' The body is suboval, but deeply incised behind the fourth segment of the peræon. The second antennæ are long; the mandibles have a molar tubercle, and either have a small three-jointed 'palp' or are without one. The first limbs of the peræon are not elongate, the second usually more robust than the rest, the third and fourth in general very elongate, the fifth and sixth natatory, with an unguiform seventh joint, the seventh long and slender, with the joints scarcely flattened, the nail long and curved. The uropods are simple, lying close to the pleon. Sars has described five Norwegian species, of which the first was *Ilyarachna longicornis*. *Ilyarachna quadrispinosa*, Beddard, was brought by the *Challenger* from Kerguelen.

Desmosōma, Sars, 1864, 'a chain-like body,' has the segments marked off by constrictions which are commonly deep; the three hinder segments of the pleon are larger than those which precede. The second antennæ are shorter than the body, slender in the female, robust in the male. The mandibles have a dentate cutting-edge, spine-row, molar, and usually a three-jointed 'palp,' ending in a long unguiform spine. The first four pairs of limbs are short and robust, the last three natatory, but with the fifth and sixth joints not greatly expanded, edged with spines that are flattened but not plumose; the seventh joint is narrow and stiliform. The uropods are simple, two-jointed, the last joint being the larger. Sars has described four Norwegian species, *Desmosoma lineare*, *armatum*, *aculeatum*, and *tenuimănum*, of which *aculeatum* has no mandibular 'palp.'

Acanthocōpe, Beddard, 1885, has the side-plates of the peræon, except the first pair, furnished with long spine-like processes, and the pleon ending in an elongate spine-like process. The mandibles have a powerful molar and a small, three-jointed 'palp.' The hind limbs of the peræon have a natatory character. The uropods are simple, long, and stiliform, from three- to five-jointed. In *Acanthocope spinicauda*, taken from a depth of 1,800 fathoms in the Southern Ocean, the five-jointed uropods present a feature unique in this tribe. *Acanthocope acutispina*, from South America, has three-jointed uropods, and the first antennæ with a short flagellum instead of a very long one as in the companion species.

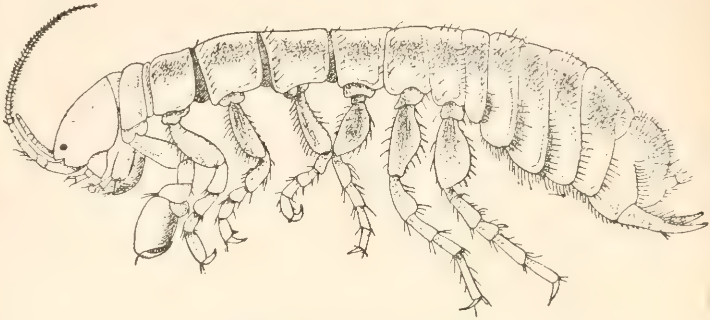
CHAPTER XXV

TRIBE V.—PHREATOICIDEA

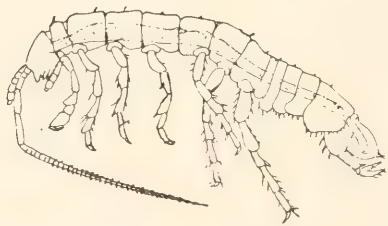
Family Phreatoicidæ.

Phreatoicus, Chilton, 1882. The only genus.

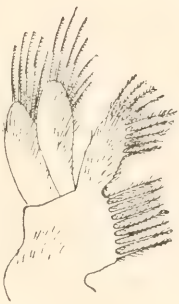
The animal is long, subcylindrical, laterally compressed. The seven segments of the peræon are distinct, with small distinct side-plates. The pleon has six distinct segments, the first five laterally produced downwards, the fifth longer than any of the preceding four, the sixth dorsally fused with the telson, but distinguished from it by lateral sutures or setose ridges. The eyes are small and lateral or absent. The first antennæ are short, the flagellum subterminally thickened and carrying olfactory filaments; the second antennæ have a five-jointed peduncle and a flagellum exceeding it in length. The mandibles have a dentate cutting edge, accessory plate on the left mandible only, a long spine-row, strong molar, and three-jointed 'palp;' the lower lip is bilobed; these and the other mouth-organs agree in all important respects with those of *Asellus*, only that in the maxillipeds the fourth joint is strongly produced on the outer side. The first limbs of the peræon are subchelate, of the 'gnathopod' form. The rest are ambulatory, the last three pairs facing those in front as in most of the Gammaridea. All the pleopods have the outer branch ciliated, the inner and smaller branchial; the first pair have narrow branches; the second have in the male the usual stilets, which are curved and semicylindical, and the outer branch both in this and the following pairs is two-jointed. The uropods



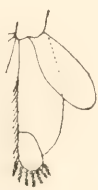
Phreatoicus australis



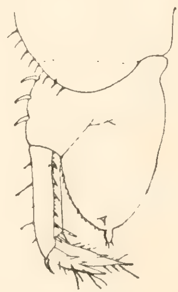
Phreatoicus typicus



P. typicus·
2^{nd} *Maxilla*



P. typicus
2^{nd} *Pleopod*



P. typicus
Telson and Uropod

are infero-lateral in position, with a strong spinigerous peduncle and two spinigerous branches.

The type-species is *Phreatoicus typicus*, Chilton, 1882, from a pump at Eyreton in New Zealand. In this species the eyes are not visible, the second joint in the limbs of the peræon is very slightly expanded, and in the seventh pair is shorter than the following joint. The pleon is remarkable for the great length of the fifth segment, a character not met with elsewhere either in the Isopoda or Amphipoda, though it is a distinguishing feature of the Cumacea. In regard to colour the animal is described as transparent.

Phreatoicus australis, Chilton, 1891, was obtained by Mr. R. Helms from Mount Kosciusko in Australia. The specimens were taken, he says, at a place 'locally known as "Piper's Creek," at an elevation of 5,700 feet or perhaps rather more, on the track from "Pretty Point" towards the "Ram's Head." The creek (or at least a branch of it) runs here through a, in damp weather, boggy flat, and at the time (early in March 1889) was slowly trickling along forming puddles here and there. In one of these puddles where there was only a little water covering the black bog mud, perhaps from two to three inches, I made the find. In turning the stones (flat pieces such as frost will split from rocks—not boulders) I found no difficulty in picking the animals off, the most of them keeping quiet. They were pretty numerous under the stones, when at all, and looked exceedingly like the surrounding earth. Through this and their quiet habit I did not notice at first that they were so numerous, but seeing that they were interesting things (I had not seen anything like it before) I took pretty well all I could lay hands on; and this is the only time and place I have collected them although I have many a time turned stones in the neighbourhood and in similar localities.' Mr. Chilton supplies the not uninteresting detail that 'on March 13th at "Pretty Point" Mr. Helms found the remains of his tea completely frozen in his billy.' This new species is distinguished from the

type by having eyes, which are small but distinct, the second antennæ shorter, the second joint in the limbs of the peræon more dilated, and the pleon furry. In describing this species Mr. Chilton mentions that the third pleopods have on the outer margin of the basal portion 'an ovate appendage which perhaps represents the *epipodite*.' He finds the males distinguished from the females not only by the special organs at the base of the seventh pair of limbs, but by rather stronger hands in the first pair, and a clasping arrangement in the last two joints of the fourth pair. The female appears to have brood-plates on the second, third, and fourth segments of the peræon.

The figures in Plate XVI. are copied from the papers in which Mr. Chilton describes the two notable species under discussion.

While the mouth-organs and pleopods make *Phreatoicus* an unquestionable Isopod genus, the affinity with the Amphipoda appears not a little remarkable. The lateral compression of the body, the downward lateral production of the pleon-segments, the arrangement of the limbs of the peræon, the considerable development of the pleon, the two-jointed branch in several of the pleopods, the strong indication of a distinction between the sixth pleon-segment and the telson, and above all the position and structure of the uropods, form a group of characters which bring this genus nearer to the Amphipoda than any other Isopod can claim to be. In the limbs of the peræon the third joint is not very short, as it usually but by no means always is in the Gammaridea, nor does the fourth joint in the first pair *underride* the fifth as is usual in the gnathopods of the Gammaridea. On the other hand the clasping arrangement of the fourth pair of limbs is strikingly parallel to what is found in the Orchestiidæ, and, as Mr. Chilton points out, the expansion of the second joint of the limbs in *Phreatoicus australis* is similar to what is found in so many of the Amphipoda. In his admirable discussion of all the characters Mr. Chilton is inclined to disallow the Phreatoicidæ any special proximity to the Amphipoda, and is thus induced to remark that

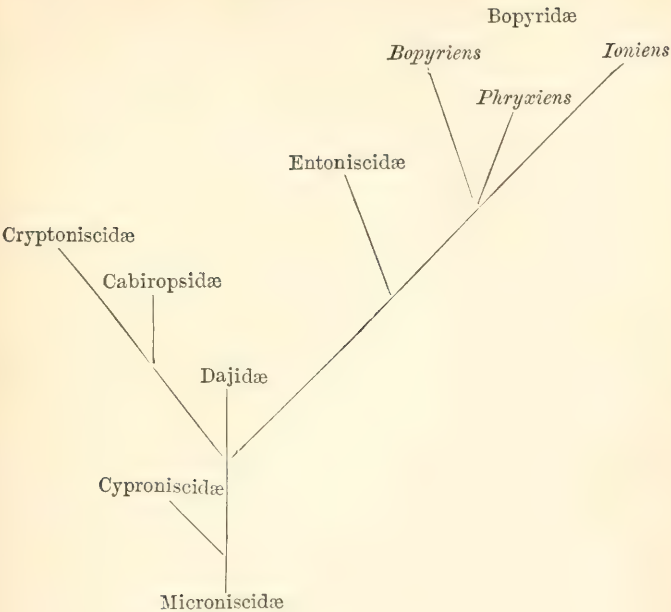
the uropoda 'present no greater resemblance to the Amphipoda than to several of the Isopoda such as *Asellus*,' although the position alone would suffice to distinguish them from those of *Asellus*, and if disjoined from the animal there is absolutely nothing about them that would enable any one to say that they belonged to any Crustacean except their own or some Amphipod genus. The spine at the lower end of the peduncle occurs as so often in the Amphipoda. The genus and its two species are beyond dispute remarkable, requiring to be placed in a separate family, and though some may prefer to class this among the Asellota, I have ventured to think that a separate tribe Phreatoicidea should be instituted to receive it.

CHAPTER XXVI

TRIBE VI.—EPICARIDEA

This tribe consists of Crustacea which in the adult state are parasitic upon other Crustacea, to which allusion is made in the tribal name signifying 'dwellers upon shrimps.' The females become degraded in form and often very unsymmetrical, while the males, much smaller and symmetrical, are often free, but usually do not quit their partners.

The notion entertained of old by the French fisher-folk, that the *Bopyri* in the prawn were young flat-fish, received scientific support from M. Deslandes in 1722, but in 1772 was disproved by M. Fougeroux de Bondaroy. For some sixty or seventy years after his time the knowledge of the group was but slowly advanced. Remarkable forms were obscurely described by Cavolini, Montagu, and Risso. Others were made known later on with clearer definition by H. Rathke and Kröyer. Duvernoy and Dana contributed new genera; and by degrees the tribe both gathered volume and evoked attention. During the last thirty years Fritz Müller, R. Kossmann, Paul Fraisse, and various other writers of eminence have thrown light upon the subject from several points of view, and in the latter part of that period the labours of MM. Giard and Bonnier have introduced order and clearness into its arrangement. The writings of these last-named observers will not soon or easily be superseded as the leading authorities on this tribe. They ascribe to it seven families, the Microniscidæ, Cyproniscidæ, Dajidæ, Cabiropsidæ, Cryptoniscidæ, Entoniscidæ, and Bopyridæ, for which they propose the following phylogenetic table :—



Microniscidæ	parasitic	on	Copepoda.
Cyproniscidæ	,,	,,	Ostracoda.
Dajidæ	,,	,,	Schizopoda.
Cabiropsidæ	,,	,,	Isopoda and Amphipoda.
Cryptoniscidæ	,,	,,	Cirripedia (chiefly the parasitic).
Entoniscidæ	,,	,,	Brachyura.
Bopyridæ	,,	,,	Brachyura and Macrura.

The Epicaridea are all, strictly speaking, external parasites, although according to position on their host they may be classified as abdominal, branchial, or visceral. In those which inhabit the branchial chambers of other crustaceans, the form of the female becomes obliquely ovate, the convex side being on the right or the left, according as the animal occupies the right or left side of its host. In some genera (*Kepon*, *Gyge*, *Ione*), a right-hand female has the marsupial plates of the right side overlapping those of the left, while the reverse is the case in a left-hand female. The plates are so imbricated that the last of the five pairs is

outermost. They are attached pair by pair to the first five segments of the peræon as in the Cymothoidæ. Giard and Bonnier regard them as representing parts of the exopods of the limbs. This seems to require what they admit to be a very hypothetical explanation of an Isopod's leg, namely, that the fourth and fifth joints are the fifth subdivided, and that the small first joint is a fusion of the first and second. By this redistribution the long second joint becomes the third, and thus matches the long third joint so frequently found in the third maxillipeds of the higher Crustacea. But convenient as the hypothesis may be for attaining this piece of symmetry, other grounds for it are not as yet forthcoming. However that may be, the authors show that the structure of these marsupial plates admits of the view that they are to a considerable extent branchial, that is, assist in the oxygenation of the blood. The first pair has a special structure and function. As examined in the genus *Cancricepon* the larger and upper member of the pair is found to be divided into two portions by a median fold with an outer crest. The front part covers the base of the maxillipeds, the lower part is covered by the opposite plate and floats freely in the marsupial cavity. There are two movements affecting this apparatus, one that alternately lifts and lowers it as a whole, the other alternately lifting and lowering the front and back. By this means a current of water is maintained both to the marsupial plates and to the embryos within them. In the podophthalmous host the water enters at the back and leaves by the front of the branchial cavity, so that in the parasite which lies with its head towards the tail of its host it naturally enters by the upper part and leaves by the lower. In the Entoniscidæ the arrangement is modified to correspond with their position among the viscera.

In regard to the chance of procuring specimens, the authors note that, to obtain 'the Cryptoniscian stage' and the young female of *Athelgue paguri*, the pleon of *Paguri* should be carefully examined in the month of September, and that these interesting forms will be found much less rare than is often supposed. Dr. Hoek records that on

examining twelve specimens of *Mysis oculata* he found six infested with young *Dajus mysidis*. On the other hand, at the Neapolitan Marine Station, Salvatore lo Bianco had opened about 10,000 Brachyura before he came across a couple of Risso's *Ergyne cervicornis*, and MM. Giard and Bonnier themselves had to sacrifice tens of thousands to provide the requisite materials for their 'Contributions à l'étude des Bopyriens.'

Should any sensitive persons regret this expenditure of life on a scientific investigation, they must remember that it is perfectly trivial compared with what is continually being exacted for the meaner purpose of tickling man's palate, trivial also compared with the havoc so frequently wrought by storms among creatures of this same class, and further, that against every crustacean destroyed must be set the lives of many others preserved which would else have been its victims.

According to the authors cited only *Portunion Kossmanni* on *Platyonichus latipes* can be called common. They opened an enormous number of *Porcellana longicornis* at ever so many points of the French coast before meeting with a specimen of *Entoniscus Mülleri* at Concarneau. Both there and at three other places they examined the Pagurid *Clibanarius misanthropus* without finding a parasite, although at Mahon in Minorca Dr. Fraisse found upon this crustacean a *Peltogaster*, a *Cryptoniscus*, an *Athelgue*, and a *Palægyge*. Thousands of *Portunus depurator* (Linn.) and *Porcellana platycheles* had in like manner yielded them no parasites. They feel ready to affirm that our common edible shrimp, *Crangon vulgaris*, is free from Bopyrids, though they remind us that *Crangon munitus*, its American congener, is infested by *Argeia*. The occurrence of Epicaridea may be called, in terms of our present knowledge, very capricious. It not unfrequently happens that, where they occur at all, they occur in some profusion, their hosts suffering as it were from an epidemic attack. One host may undoubtedly carry several species of parasite, but it is an axiom with Giard and Bonnier that both among the Epicaridea and the Rhizocephala no species of parasite has

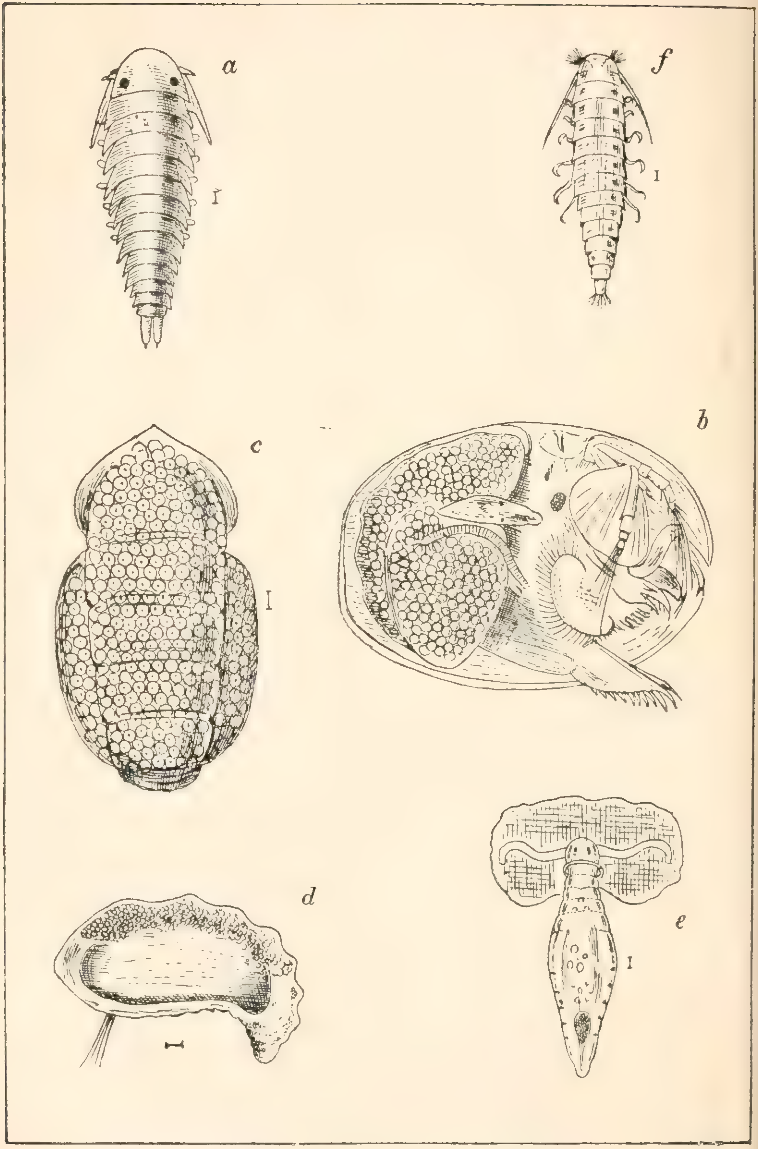
more than one host. This, if accepted, makes the distinction of species particularly easy. It is, however, a rather wide generalisation. It appears to imply that the larval forms always settle on the same species as that occupied by their parents, or perish unless they do. Yet, if the larvæ of a single brood were dispersed upon hosts of nearly related species, one might expect that to those placed in slightly novel circumstances, some difference of habit would result rather than destruction. Still the important point would remain that in each species of host the parasite is distinct in character, and in favour of their view that it is also distinct in species, Giard and Bonnier urge that 'often among closely related Epicarids there are considerable physiological differences, sometimes even morphological differences relating solely to the male or the embryo, differences too important to be attributed simply to the difference of host.'

In the relations between the Epicaridea and their hosts a very singular circumstance has recently been brought to light. Rathke and other observers had commented on the unexplained peculiarity that the infested prawns and crabs all appeared to be females, and moreover sterile females. De Haan, as heretofore remarked, not unfrequently records sterile females of a different form from the fertile females of the same crab. Giard and Bonnier have shown that an infested female is not always absolutely sterile; but a few years earlier Professor Giard made the extremely interesting discovery that the parasites attack males just as freely as the other sex. Only, under the influence of the invader the distinguishing characters of the male are hindered from development, and a sort of intermediate appearance is permanently retained.

Family 1.—*Microniscidæ.*

This includes the least degraded forms, corresponding in general aspect to the second larval form of the other families. They are parasitic on Copepoda.

Microniscus, Fritz Müller, 1870, is the only genus.



a. Microniscus calani (Sars). b–f. Cyproniscus cypridinae (Sars).

The type, *Microniscus fuscus*, found by Müller on a species of *Calanus* on the coast of Brazil, is characterised by having 'the third pair of thoracic feet longer than the others, and terminating in an oval lamella, by which the animal fixes itself on its host.' *Microniscus calăni*, Sars, 1882 (see Plate XVII.), with all seven pairs of feet similar, fastens itself to the back of *Calanus finmarchicus*, Gunner, and, according to Sars, also to *Pseudocalanus elongatus*, Boeck. It is possible, however, that the parasites on the latter Copepod have not been specially examined to determine their identity with those on the former. *Microniscus calani* has the pleopods two-branched, a character which 'is only met with exceptionally in the cryptoniscian embryo of the Entoniscidæ and the Bopyridæ, while it is the rule in the Cryptoniscidæ.'

Family 2.—Cyproniscidæ.

They are parasitic on Ostracoda.

Cyproniscus, Kossmann, 1884. The characters of the family and genus rest on those of a single species, *Cyproniscus cypridinæ* (Sars), 1882 (see Plate XVII.), which is thus described:—'The adult female, deprived of all the mouth-organs and appendages, with the whole body filled with eggs, sack-like, curved, the arched middle of the back divided into six or seven indistinct segments, the ventral side flattened, the sides slightly expanded, the frontal part widely cordate, exserted, defined by an emargination on either side from the lateral parts. The male (? when adult) like the female devoid of appendages, with the body spindle-shaped, indistinctly segmented, the anterior extremity furnished on either side with a long flexuous root-like process for fixation. An advanced larval stage resembling *Cryptothiria pygmæa* in form and structure, but a little more elongate, and quite without eyes.' Sars found these queer animals at the Lofoden Isles fixed within the valves of *Cypridina norvegica*, Baird, to the hindmost part of the animal's back, calmly occupying the space properly belonging to the eggs of its host. As a rule he found what

appeared to be two males fixed one on each side of the female.

Family 3.—*Dajidæ.*

They are parasitic on Schizopoda. In the adult female the trunk-feet are only five pairs, and the sides of the body are folded ventrally so as to form a chief part of the marsupium, only the last pair of marsupial lamellæ retaining an important function in closing the pouch from behind.

Dajus, Kröyer, 1846. The animals of this genus are attached on the ventral side of the host. In the female, the first antennæ are tuberculiform, three-jointed, the two terminal joints minute; the second antennæ have a large basal joint, succeeded by about eight slender joints. The spoon-shaped ends of the mandibles can be projected through an opening between the upper and lower lips. Both pairs of maxillæ are rudimentary, tubercular. The maxillipeds are two-jointed, with an epipod, but no exopod. Between them is developed a triangular operculiform plate. The sixth and seventh pairs of feet disappear; the preceding five are all nearly alike. The imbricated first four pairs of marsupial plates form a movable lid to the front opening of the marsupium. The large fifth pair close it behind, in combination with the inner branches of the first pleopods. The remaining pleopods are rudimentary, the second, third, and fourth being bilobed, but the fifth consisting of a pair of simple tubercles. The uropods also are simple, but a little more elongate. The adult male is placed between the first pleopods of the female. It has the first segment of the peræon fused with the head; the pleon is a single piece without pleopods. The first antennæ are four-jointed, the second eleven-jointed. The mouth-organs consist of strong mandibles and tubercular first maxillæ and maxillipeds. The male, in the earlier 'cryptoniscian stage,' has seven distinct segments in the peræon and six in the pleon, with appendages to each, those of the pleon being all biramous, with the branches set wide apart on the broad peduncle.

Hoek has stated that the male in this stage is compressed laterally, so as to look like an Amphipod, and that it is fixed to the body of the female by the aid of a sucker. Giard and Bonnier remark that the lateral compression would be very astonishing, since all the Epicarids in the cryptoniscian stage tend to be flattened. From specimens sent me by Dr. Fulton of the Scotch Fishery Board, I should say that these cryptoniscian forms of the male were decidedly flattened, not compressed, but these specimens were taken or found apart from females, whereas Dr. Hoek's may have been modified by their position as attached to the female. The suboral circular sucker is a conspicuous object, which attracted Dr. Fulton's attention at once. It appears to have escaped notice that this ring is shown in the figure of *Dajus mysidis*, Kröyer, on plate 28, fig. 1A, of the 'Voyages en Scandinavie, &c.' Dr. Hoek has figured the curious hand-shaped spines on the sixth joint of the legs. Some of these spines are split as it were into five fingers and a thumb.

Three species are at present allotted to the genus:—

Dajus mysidis, Kröyer, 1846, on *Mysis oculata* (Fabricius).

Dajus mixtus, Giard and Bonnier, 1889, on *Mysis mixta*, Lilljeborg.

Dajus siriellæ, Sars, 1885, on *Siriella Thompsonii* (Milne-Edwards).

Aspidophryxus, Sars, 1882. The animals are attached to the back of the peræon of the host. The female is much more curved than in *Dajus*. It has the five pairs of feet more elongate, the first four pairs of marsupial plates very small, not overlapping from side to side, the last pair very elongate, soldered together longitudinally; the pleon unsegmented, without appendages. In the male the pleon has an indication of the segments of which it is composed, the sixth especially being distinct; the only appendages are the two-jointed uropods.

Aspidophryxus peltatus, Sars, 1882, on *Erythrops erythrophthalmus* (Goës). Eggs many and small.

Aspidophryxus Sarsi, Giard and Bonnier, 1889, on

Erythrops microphthalma, Sars. Eggs few and large. Upon this species Giard and Bonnier have found a parasitic Copepod, which thus retaliates upon the Isopods that are parasitic on Copepoda.

Notophryxus, Sars, 1882. The animals are attached to the back (or side) of the host. In the female the body is symmetrical, a little depressed, imperfectly segmented, the first antennæ are laminar, the five pairs of feet are small, incompletely articulated, and crowded into a narrow space on either side of the mouth. The pleon is without appendages. The male has the peræon clearly segmented, with the full number of appendages, the pleon unsegmented, without appendages.

Notophryxus ovoides, Sars, 1882, on *Amblyopsis abbreviata*, Sars.

Notophryxus clypeatus, Sars (1880), on *Pseudomma roseum*, Sars.

Notophryxus lateralis, Sars, on *Nematoscelis megalops*, Sars. This is thought likely to become the type of a new genus.

Notophryxus globularis, Sars, 1885, on *Thysanoessa gregaria*, Sars.

Heterophryxus, Sars, 1885. The animals are attached to the back of the host. The female has the back pretty distinctly segmented, the five pairs of feet distant from one another, and the fifth pair remote from the rest, directed backwards, bifurcate; the pleon rudimentary, with the male adhering to this rudiment.

Heterophryxus appendiculatus, Sars, 1885, on *Euphausia pellucida*, Dana.

Family 4.—Cabiropsidæ.

They are parasitic on Isopoda and Amphipoda.

Cabirops, Kossmann, 1884, for *Cabira*, Kossmann, 1872, preoccupied, is described as having '8-9 distinct segments, divided by a chitinous lamella into dorsal and ventral halves; mouth in the ventral part of the first segment; pouch-like appendages of the single segments filled with embryos' ('Zool. Record,' 1872).

Cabirops lernæodiscoides, Kossmann (1872), was found in the brood-cavity of a *Bopyrus* from the Philippines. To this genus Giard and Bonnier approximate *Cryptothiria (?) marsupialis*, Sars, reported to be parasitic on *two* species, *Eurycope cornuta* and *Ilyarachna longicornis*. The female only of this parasite is known. It is a simple pellucid broadly bilobed sack, narrowed in front, filled with eggs, with an ovate oral area, and no appendages.

Podascon, Giard and Bonnier, 1889. 'All the body of the female is, so to speak, transformed into a vast incubatory chamber, enclosed by two lateral plates extending from the first to the fifth segment of the peræon and united along the median line so as merely to leave at either end an opening for the passage of water.'

Podascon Dellavallei, Giard and Bonnier, 1889, on the Amphipod *Ampelisca diadema* (Costa). When first described, this was the only known instance of an Isopod parasitic on an Amphipod. New forms have since been found by M. Chevreux on three other species of *Ampelisca*. Also a Cryptoniscus-form found by Gourret on *Leucothoe spinicarpa* in the Ascidian *Phallusia gelatinosa*, may in the opinion of MM. Giard and Bonnier prove to belong to the Cabiropsidæ. A Cryptoniscus-form found by myself among the eggs of an *Onisimus plautus* (Kröyer) from the Arctic regions, closely agrees with the *Hemioniscus balani* of Buchholz, which is a member of the next family.

Family 5.—Cryptoniscidæ.

They are parasitic on Cirripedes, chiefly on the parasitic Rhizocephala. It is reasonable to believe that the Rhizocephala did not begin their existence as parasites, but descended from independent Cirripedes. Fritz Müller ingeniously suggests that in becoming parasitic they took with them their own parasites, the Cryptoniscidæ. Giard and Bonnier further suggest that the Entoniscidæ and Bopyridæ were introduced to the higher Crustacea by ancestors parasitic on Rhizocephala, and that in course of time they found their advantage in exchanging an indirect for a direct parasitism.

In the Cryptoniscidæ the first two segments of the peræon carry very short feet, sometimes degraded, provided at the extremity with a strong claw; the pleopods are two-branched. The adult female, without becoming unsymmetrical, loses the characteristic shape of an Isopod and all or most of its appendages.

The Epicaridea in general pass, according to Giard and Bonnier, from the embryo or first stage of their development to a second or cryptoniscian stage, in which they resemble the males of this family. According to Dr. Fraisse the free-swimming Cryptoniscidæ have a quite peculiar smell, and the female becomes sexually mature before adopting a parasitic life. Notwithstanding Professor Kossmann's scepticism regarding the latter statement, I believe that it is correct. At all events a minute specimen taken in the tropical Atlantic, retaining all its appendages, and of the shape usual in the 'cryptoniscian stage,' appears to have ovaries crowded with eggs.

Cryptoniscus, Fritz Müller, 1864. The characters noticed by Fritz Müller are that the young of *Cryptoniscus* are, like most other Isopods, hatched with the last peræopods undeveloped, and that the penultimate pair are thin and rod-like, differing much from those which precede them.

Cryptoniscus planarioides, Fritz Müller, 1864, was found on *Peltogaster purpureus* (F. Müller), together with *Phryxus resupinatus*, on a Pagurid, in Southern Brazil. Fritz Müller remarks of this species, that, if the eggs and young did not betray the crustacean character, the female would almost rather be taken for a flat-worm (a Planarian) than for an Isopod.

The *Peltogaster*, it must be understood, is a strangely metamorphosed Cirripede, which pushes roots into the body of its Pagurid host. Then comes the *Cryptoniscus*, penetrates the parasite, and draws nourishment to itself through those piratical roots. Strangely it happens next that under this infliction the body of the Cirripede, cheated of its nutriment, dies and falls away, and yet its roots remain and flourish for the benefit of an alien digestive apparatus. Crustaceans of three distinct orders are thus

brought together, and, as it were, jumbled up into a sort of compound animal, so that when the Pagurid devours a shrimp, its gastronomic exertions are supplying food through the remnants of a shapeless Cirripede to a degraded Isopod. This remarkable arrangement on the body of a hermit-crab, itself occupying the shell of a departed mollusc, must be regarded as the result of special creation by those who still uphold the venerable doctrine of the fixity of species. What a gasp an intelligent mind must give at swallowing such an explanation!

Cryptoniscus paguri, Fraisse, 1878, was found on *Peltogaster Rodriguezii*, Fraisse, on *Clibanarius misanthropus*, Risso, at Mahon in Minorca. It is described as flat and worm-like, much resembling the preceding species.

Cryptoniscus larvæformis, Giard, 1874, on *Sacculina carcini*.

Danalia, Giard, 1887, was substituted for part of *Zeuxo*, Kossmann, 1872, preoccupied.

Danalia curvata (Fraisse), 1878, on *Sacculina neglecta*, Fraisse, from the Bay of Naples, is said to be round and rolled together, very like the *Cabirops lernæodiscoides* of Kossmann. Dr. Fraisse says that it is either a simple parasite on the *Sacculina*, or placed beside it on the crab *Inachus scorpio*, Fabricius, but that in any case it has to draw its nourishment from the roots of the *Sacculina*.

Danalia Lobiancoi, Giard and Bonnier, 1890, on *Portunascus corrugatus*, Giard.

Danalia Dohrni, Giard, 1887, on *Grapsisaccus Benedeni*, Kossmann. The *Zeuxo longicollis* of Kossmann, 1880, was found on the pleon of *Chlorodius* (*Leptodius*) *exaratus*, Milne-Edwards, in company with but remote from a *Sacculina*.

Liriopsis, Max Schultze, 1859, was substituted for *Liriope*, Rathke, 1843, preoccupied.

Liriopsis pygmæa (Rathke), 1843, on *Peltogaster paguri*, Rathke. The first antennæ have a very thick bundle of hairs attached to the outer side of the basal joint in the male.

Liriopsis monophthalma (Fraisse), 1878, on *Peltogaster*

curvatus, Kossmann, is said to have a cylindrical form, and to be nearly related to the preceding species.

Eumetor, Kossmann, 1872. 'The male allied to *Liriope* (Rathke), but without antennæ; the female much larger, its segmentation continuing in the mature state.' ('Zool. Record,' 1873).

Eumetor liriopides, Kossmann, 1872, in the mantle-cavity of *Sacculina pisiformis*, from the Philippines. Dr. Fraisse, discussing specimens which he supposes to belong to this genus, from the mantle of *Sacculina Benedenii*, says that no brood-cavity is present, the Isopod being content to use the mantle of the *Sacculina* for that purpose. He also says that the male of Kossmann's species 'has no olfactory setæ on the inner antennæ.'

Cryptothir, Dana, 1852, on non-parasitic Cirripedes.

Cryptothir minutum, Dana, in the corallidomous barnacle *Creusia*, at the Fiji Islands.

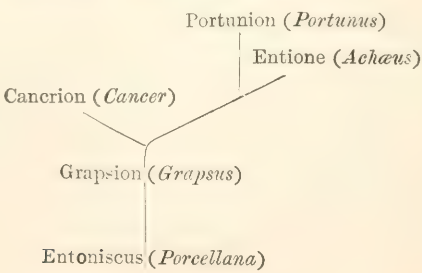
Cryptothir balani (Bate), 1861, on *Balanus balanoides*. The larval form, as taken with the tow-net in the Clyde, has eight teeth on the basal joint of the first antennæ; the second antennæ nine-jointed; the mouth-organs forming a triangular mass, with the apex pointing backwards; the sides of the peræon, and in a less degree those of the pleon, digitate; the first two pairs of trunk-limbs not degraded, strongly subchelate, the next three pairs slightly so, the last two pairs simple, with the two terminal joints elongate; the five pairs of pleopods and the uropods two-branched, the branches tipped with setæ. According to Bate and Westwood, the adult sedentary female is a lobate sack-formed mass without any appendages.

The genus *Hemioniscus*, Buchholz, 1866, is said to be a synonym of *Cryptothir*. But according to Buchholz the adult female of his *Hemioniscus balani* retains the front part of the larval form. This, however, may not be permanently the case. Beddard mentions a Bopyrid in the larval stage attached to *Serolis cornuta*, Studer, on the dorsal surface of some of the anterior segments, and 'apparently belonging to the genus *Hemioniscus*,' but this parasite has not been described.

Leponiscus, Giard, has the single species *Leponiscus pollicipedis*, parasitic, as the name indicates, on a pedunculate Cirripede.

Family 6.—*Entoniscidæ.*

The animals are parasitic (to appearance) within the bodies of Brachyura, entering through the branchial into the visceral cavity. In the females the body is extremely unsymmetrical, with traces of segmentation when young; the head is swollen into a double sphere, the antennæ are metamorphosed into lips; the labrum, hypostome and mandibles forming the oral apparatus. The maxillipeds are lamellar, the feet rudimentary, the marsupium formed of five pairs of plates, with the first pair situated between the rest; the ovaries opening at the base of the fifth pair of feet, and by their prolongations determining the shape of the peræon; the pleon has six segments, furnished with lamellar or sabre-shaped pleopods. In the minute male there are two rudimentary eyes, the antennæ are evanescent, the maxillipeds are rudimentary, the seventh segment of the peræon is without appendages; the six segments of the pleon are without pleopods. The embryo has two eyes, sometimes a nauplian eye, the second antennæ elongate, six pairs of feet, five pairs of pleopods and even a pair of uropods. In the 'Cryptoniscian stage' there are seven pairs of feet. MM. Giard and Bonnier give a provisional genealogical tree of the Entoniscidæ in connection with their hosts.



These are in reality ectoparasites, though with an appearance of being endoparasites. The sheath or enveloping membrane moulded on every detail of their bodies is an invagination of the hypodermis of the crab in which the Entoniscid lives.

Entoniscus, Fritz Müller, 1862. Parasitic on Porcellanidæ. The female has the marsupium open when adult, with deeply cut edges to the component plates, and an elongate pleon with five pairs of sabre-shaped pleopods. The male is comparatively large, with the first antennæ elongated, six pairs of trunk-feet reduced to pedicellate tubercles, and the last segment of the pleon not slit.

Entoniscus porcellanæ, Müller, 1862, on *Porcellana* sp.

Entoniscus Mülleri, Giard and Bonnier, 1886, on *Porcellana longicornis* (Linn.).

Entoniscus brasiliensis, Müller, 1871, on *Porcellana* sp.

Entoniscus Creplinii, Giard and Bonnier, 1887, on *Porcellana* (Polyonyx), *Creplinii*, Müller. Fritz Müller found a couple of the *Porcellana* in almost every tube of the Chæptopteri at Desterro. Only three times did he find the *Porcellana* solitary, once a female, twice a male. Only on these three specimens did he find an *Entoniscus*. The parasite makes the animal sterile, and it is inferred that the infested crabs either could not find or retain partners. Possibly they did not make the attempt to do either one or the other.

Entiōne, Kossmann, 1881. The male has the last segment of the pleon terminally bifid. This genus since its institution has been much subdivided, and the original name limited to Entoniscidæ parasitic on Oxyrrhyncha.

Entione achæi, Fritz Müller, on *Achæus* sp.

Grapsion, Giard and Bonnier, 1886. Parasitic on Grapsidæ. The female has the marsupium closed when adult, the ascendant lamella of the first pair of marsupial plates narrow all along; there are two medio-ventral and two latero-dorsal ovarian bosses and four dorsal tubercles; the pleopods lamellar, little recurved. The male has the sixth segment of the pleon ending in two recurved hooks.

The embryo has a nauplian eye, and swims with the sixth pair of trunk-feet extended.

Grapsion Cavolinii, Giard (1878), on *Pachygrapsus marmoratus*, Fabricius. This species is named after Cavolini, who in 1792 described an Entoniscid from 'Granchio depresso,' which is supposed to be the same as *Pachygrapsus marmoratus*.

Cancrion, Giard and Bonnier, 1886. Parasitic on Cancridæ. The female has the marsupium closed when adult, and has four dorsal ovarian bosses. The sheath in which the animal is enclosed is always covered with thickenings of yellow chitin. The male has the pleon clearly distinct from the peræon, elongate, without ventral prominences or terminal hooks, the bilobed apex of the sixth segment being minutely squamose. The embryo has the sixth trunk-feet elongate and carries them extended laterally.

Cancrion cancrorum (Fritz Müller, 1864), on several Brazilian species of *Xantho*, implying *ex hypothesi* several species of parasite under one name. Fritz Müller states that the heart in the male is situated in the third segment of the pleon.

Cancrion miser, Giard and Bonnier, 1886, on *Pilumnus hirtellus* (Linn.) Six specimens were found. The crabs examined were more than 1,800.

Cancrion floridus, Giard and Bonnier, 1886, on *Xantho incisus*, Leach, commonly called *Xantho floridus* (Montagu). Three specimens were found to about 900 crabs examined.

Portunion, Giard and Bonnier, 1886. Parasitic on Portunidæ. The female has the marsupium closed when adult, the ascendant lamella of the first pair of plates regularly widened from the base, much recurved, the upper edge not cut; there are two medio-ventral and two latero-dorsal ovarian bosses. The male has medio-ventral hooks on the pleon, and the sixth segment apically furnished with a pair of hooks. The embryo is without a nauplian eye, and swims with the sixth trunk-feet carried under the pleon.

Portunion mænadis, Giard, 1886, on *Carcinus mænas*

(Pennant) (see Plate XVIII.). The specimens found were in about one per cent. of the crabs examined.

Portunion Salvatoris (Kossmann, 1881), on *Portunus arcuatus*, Leach.

Portunion Moniezii, Giard (1878), on *Portunus puber* (Linn.). Excessively rare.

Portunion Fraissei, Giard and Bonnier, 1886, on *Portunus holsatus*, Fabricius.

Portunion Kossmanni, Giard and Bonnier, 1886 (see Plate XVIII.), on *Platyonichus latipes* (Pennant).

This is the only species that can be called common, and one which does not necessarily sterilise the host or hinder the exuviation of its integument. These are probably the conditions that have allowed it to become common, since, when the parasite makes the host sterile, it, so to speak, cuts the ground from under its own feet, by preventing the propagation of the very animal which is essential to the existence of the parasite's own progeny.

Pinnotherion, Giard and Bonnier, 1889. Parasitic on *Pinnotheres*. The first marsupial plate is without a transverse lamella, and its recurrent part is of unusual length. There are no dorsal ovarian humps, but of the ventral two the hinder is excessively long and cylindrical, with vermiform movements, whence the type species is called *Pinnotherion vermiforme*.

Family 7.—*Bopyridæ*.

The animals are parasitic in the branchial cavity, with a few exceptions. The females in general have a flattened appearance with one side longer than the other. Giard and Bonnier, as already mentioned, subdivide this family into *Phryxiens* chiefly found on Macrura Anomala, *Ioniens* on Brachyura, and *Bopyriens* on regular Macrura. In the *Bopyriens* the pleon is very degraded in both sexes, in the male a single piece without appendages, in the female shorter than in the *Ioniens* and never carrying ramified appendages. These latter on the other hand are the rule in the *Ioniens*, of which moreover the males sometimes

have pleopods or rudiments of them. The *Phryxiens* are considered to represent the stem out of which the other two divisions arise as branches.

Phryxus, Rathke, 1843, is preoccupied, but MM. Giard and Bonnier retain it, though transferring Rathke's *Phryxus paguri* to *Athelges*. The male has the pleon fused and without appendages.

Phryxus resupinatus (Müller), 1870, was found on a Pagurid from Brazil, generally in connection with *Peltogaster purpureus* and a *Cryptoniscus* already mentioned. Dr. Fraisse considers that the name *resupinatus*, meaning with the ventral side outwards, does not really refer to a specific peculiarity, but that the larva places itself under the *Peltogaster*, naturally with its ventral side towards it, and consequently with its dorsal side towards the Pagurid. When nothing of the *Peltogaster* is left but its roots, the Bopyrid, having lost its original point of support, bends back its claws to clutch the abdomen of the hermit-crab. That the parasites are not injured by the movement of the Pagurid within the mollusc shell is explained in this way. The hermit by its terminal appendages clings firmly to the twist of the shell, laying its ventral side close to the spindle of it. The parasites, however, uniformly sit on the left side of their host's back, tolerably near the carapace, just where the eggs of the healthy female Pagurid are wont to be attached.

Athelgue, Hesse, 1861, is spoken of as *Athelgus* by Fritz Müller in 1870. *Athelges* is the form generally used. It has a cylindrical pleon and flat laminar branchiæ.

Athelgue paguri (Rathke), 1843, on *Eupagurus bernhardus* (Linn.). In describing this species under the name *Phryxus paguri*, Bate and Westwood suggest that *Athelgue fullode*, Hesse, 1861, is a synonym.

Athelgue Prideauxii, Giard and Bonnier, 1890, on *Eupagurus Prideaux* (Leach). This species is larger than the preceding, and the adult female retains a rudimentary fifth pair of appendages on the pleon, which are transitory in the former.

Athelgue guitarra, Giard and Bonnier, 1890, on *Pagurus* sp.

Athelgue intermedia, Hesse, 1877, on *Eupagurus cuanensis* (Thompson).

Athelgue Cardonæ, Kossmann, on *Clibanarius misanthropus*, Risso.

Athelgue lorifera, Hesse, 1877, on *Eupagurus cuanensis* (Thompson), together with several specimens of *Peltogaster*.

Athelgue cladophora, Hesse, 1861.

Pleurocrypta, Hesse, 1865. The male has the pleon as in *Phryxus*. In the female, it is stated, 'the five segments of the pleon are provided each, on each side, near the margin, with a branchia of oval form, filiform, thin, flat, very contractile.' The sixth segment has two small appendages.

Pleurocrypta galateæ, Hesse, 1865, on *Galathea squamifera*, Leach. According to Giard and Bonnier the *Phryxus longibranchiatus* of Bate and Westwood is the Phryxus stage of this *Pleurocrypta*.

Pleurocrypta porcellanæ, Hesse, 1877, on *Porcellana longicornis* (Linn.).

Pleurocrypta strigosa, Giard and Bonnier, 1890, on *Galathea strigosa*, Fabricius.

Pleurocrypta Hendersonii, Giard and Bonnier, 1890, on *Galathea dispersa*, Bate, from the Clyde.

Palægyge, Giard and Bonnier, 1888. The male has the pleon composed of well-separated segments, each on the ventral side carrying rudiments of pleopods. The authors in 1890 suggest that it will probably be necessary to make two sections of the genus, one characterised by the plates of the pleon in the female being furnished with warts or tubercles, and including the species parasitic on *Anomala* and *Thalassinida*, the other characterised by the appendages of the pleon being entirely smooth, and including the species parasitic on the *Eukyphota* (see page 224). For the former division the genus *Pseudione*, Kossmann, seems to be the appropriate name, and for the latter *Palægyge*. As the name implies, this genus is regarded by its authors as representing an ancestral form of *Gyge*.

Palægyge Borrei, Giard and Bonnier, 1888, on the freshwater species *Palæmon dispar*, von Martens.

Palægyge Bonnieri, Max Weber, 1892, on *Palæmon lar*, Fabricius.

Palægyge fluviatilis, Max Weber, 1892, on *Palæmon lampropus*, de Man.

Palægyge de Mani, Max Weber, 1892, on *Palæmon pilimanus*, de Man.

Palægyge affinis (Sars, 1882), on *Pandalus leptorhynchus*, Kinahan.

Palægyge Hoyli, Giard and Bonnier, 1890, on *Pandalus annulicornis* (i.e. *Montagui*), Leach.

Pseudione, Kossmann, 1881, has the 'maxillipeds of the male quite rudimentary.'

Pseudione callianassæ, Kossmann, 1881, on *Callianassa subterranea* (Montagu). Since Giard and Bonnier refer this species to their *Palægyge*, and also, as just observed, look forward to a subdivision of that genus, questions of priority will be best arranged by retaining *Pseudione* for one of the sections.

Pseudione Hyndmanni (Bate and Westwood, 1867), on *Eupagurus bernhardus* (Linn.). This is described in the 'History of British Sessile-eyed Crustacea' as *Phryxus Hyndmanni*. Moreover, the *Phryxus fusticaudatus* of Bate and Westwood is, according to the often quoted authorities, the phryxoid stage of the same species. By phryxoid stage is meant the form of the female immediately following the cryptoniscian stage.

Pseudione Fraissei (Kossmann, 1886), on *Clibanarius misanthropus*, Risso.

Pseudione Dohrni (Giard and Bonnier, 1890), on *Callianassa truncata*, Giard and Bonnier. This parasite was in one instance found on each side of the host.

Pseudione insignis (Giard and Bonnier, 1890), on *Munida rugosa* (Fabricius).

Pseudione confusa (Norman, 1869), on *Galathea dispersa*, Bate. This was erroneously assigned at first to *Galathea intermedia*, Lilljeborg, and described by Bate and Westwood as *Phryxus galatheæ*, and supposed by them to be

the same as *Pleurocrypta galatheæ*, Hesse, from which, however, it is distinguished by the clearly segmented pleon and rudimentary pleopods.

Gyge, Cornalia and Panceri, 1861. The lateral prolongations of the pleon are simple, unless transiently double in the young female.

Gyge galatheæ, Bate and Westwood, 1867, on *Galathea squamifera*, Leach, from the Channel Islands.

Gyge branchialis, Cornalia and Panceri, 1861, on *Upogebia stellata* (Montagu). In the branchial cavity of the host the parasite here as in other instances has its back turned to the host's body, the ventral side with the marsupial plates turned outwards. When the brood is far developed, it causes a bulging of the host's carapace, by which the whole parasitic family is securely retained. At other times, as Dr. Fraisse observes, the sharp claws, which would be unable to grasp the smooth carapace, curve back to clutch the branchiæ.

Kepon, Duvernoy, 1840. The female has the feet ending in an inflated joint, without claw. The adhesive processes (supposed in general to represent the exopods) are well developed, papillose, in the first four pairs, rudimentary on the other three. The appendages of the pleon are coarsely pinnate.

Kepon typus, Duvernoy, 1840, on an unknown crab in the Mauritius.

Leidya, Cornalia and Panceri, 1861. The female has the feet ending in a blunt claw, the adhesive processes of all seven pairs nearly equal. The appendages of the pleon form sharp finely-fringed branches. The male has the first antennæ three-jointed, the second seven-jointed, the pleon segmented, carrying five rudimentary pleopods and two long appendages on the sixth segment.

Leidya distorta (Leidy, 1855), in *Gelasimus pugilator*, Bosc.

Grapsicēpon, Giard and Bonnier, 1887. The female has the feet ending in a short sharp claw, the adhesive processes oval, not warty. The pleon appendages of the

first four segments are three-branched, of the fifth two-branched, all coarsely fringed.

Grapsicepon messoris (Kossmann, 1880), in *Metopograpsus messor* (Forskål).

Grapsicepon Fritzii, Giard and Bonnier, 1887, in a Brazilian *Grapsus (Leptograpsus rugulosus ?)*.

Grapsicepon Edwardsi, Giard and Bonnier, in *Planes minutus* (Fabricius), found occupying both sides of the same host.

Cancricēpon, Giard and Bonnier, 1887. The female has the feet ending in a short sharp claw, the adhesive processes rudimentary, the ovarian bosses numerous. The first five segments of the pleon are laterally three-branched, the dorsal branch tuberculose; the sixth segment carries two long appendages. The male has the first antennæ three-jointed, the second five-jointed; the pleon segmented, carrying very rudimentary pleopods; the sixth segment has some rough hairs or little wrinkled scales.

Cancricepon elegans, Giard and Bonnier (1886) (see Plate XVIII.), in *Pilumnus hirtellus* (Linn.). The *Pilumnus* is abundant at Wimereux among the vast collections of tubes of *Sabellaria alveolata*. In about one per cent. of the times that the parasite was found, it occurred on both sides of the same crab. The authors once found this species and *Cancrion miser* on the same specimen of *Pilumnus*. They compare the central prolongation of the pleon in the embryo with that in the embryos of some Cirripedes and Merostomata.

Cancricepon pilula, Giard and Bonnier (1886), in *Xantho incisus*, Leach.

Ergyne, Risso, 1816. The female has the adhesive processes strong and muscular, the pleon appendages fringed, the first five two-branched, the sixth simple. The male has the maxillipeds rudimentary, the pleon without distinct segments or appendages.

Ergyne cervicornis, Risso, 1816, in *Portunus arcuatus*, Leach. Giard and Bonnier identify *Portunicepon portuni* (Kossmann, 1881) with Risso's species, so that the restoration of Risso's generic name seems inevitable, little as

Risso's obscure descriptions entitle him to honour or gratitude. In the present instance, it is said, he mistook the tail of the parasite for its head, and considered the appendages of the pleon to be ramified plumose antennæ. Evidently Latreille was puzzled by the description, for in 1825, under the genus 'Ichthyophile (*Cymothoa*, Leach),' he says, '*L'ergina cervicornis* de M. Risso me paraît être un ichthyophile, ayant accidentellement un corps étranger (algue ?) aux antennes.' In this species it is observed that 'the colour of the ovary and consequently that of the largest part of the body is of a brilliant carmine red.'

Gigantione, Kossmann, 1881. The female has an almost circular outline, all the segments having unbranched prolongations. The three-jointed first antennæ have the basal joint expanded so as to cover the oral region, just leaving space for the protrusion of the points of the mandibles. The tiny feet have a short pointed nail. The marsupial plates are very large. The first pleopods form acuminate sacks with sparingly ramified out-growths on the surface; the following pairs are small, entirely ramose. The male has the pleon distinctly segmented, with six pairs of oval sack-like pleopods.

Gigantione Moebii, Kossmann, 1881 (see Plate XVIII.), in *Rüppellia impressa*, de Haan.

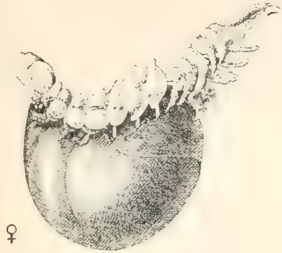
Iōne, Latreille, 1818. The female has the side-plates well developed on the head and peræon, those of the first five segments of the pleon arborescent, coralloid, the appendages of the sixth segment simple, cylindrical, recurved at the extremity. The male has the second antennæ seven-jointed, and the pleon furnished with six pairs of long cylindrical appendages.

Ione thoracicus (Montagu, 1808), in *Callianassa subterranea* (Montagu), was first recorded from Devonshire.

Ione cornutus, Spence Bate, 1864, in *Callianassa longimana*, Spence Bate.

Ione vicina, Giard and Bonnier, 1890, in *Callianassa truncata*, Giard and Bonnier.

Ione gebiæ, Giard and Bonnier, 1890, in *Upogebia stellata* (Montagu).



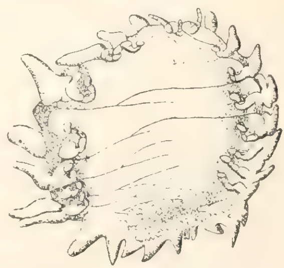
Cancricepon elegans

Portunion mænadis
on Carcinus mænas

C. elegans ♀ with ♂

Portunion Kossmanni

Gigantione Moebii. *Dorsal view*



G. Moebii. *Ventral view*

Argeia, Dana, 1852. In the female the side-plates of the segments are developed into long lobes, but without adhesive processes. The pleopods are short, not ramified. In the male the pleon is unsegmented, and without appendages.

Argeia pugettensis, Dana, 1852, in *Crangon munitus.*

Argeia depauperata, Stimpson, 1857, in *Crangon Franciscorum*, from San Francisco Bay.

Bopyrus, Latreille, 1804. In the female the boundaries of the pleon-segments are not visible in the centre of the back; the pleopods are pairs of simple rudimentary plates. In the male the pleon has no lateral appendages. Leach, in the Appendix to his 'Crustaceology,' 1814, makes the strange remark that 'the genus *Bopyrus* is to be altogether rejected from this article, as it belongs to the class Vermes.'

Giard and Bonnier give up the old name *Bopyrus squillarum*, Latreille, 1804, on the ground of the inextricable confusion of the synonymy, Latreille's *squillarum* having been indiscriminately applied to various species, and not being the oldest name, since the misleading *crangorum* of Fabricius dates from 1798, and Latreille himself appears to have confounded *Leander serratus* (Pennant) and *Leander squilla* (Linn.), so that, to start with, the name of the host is as uncertain as the name of the parasite.

Bopyrus Helleri, Giard and Bonnier, 1890, in *Leander squilla* (Linn.), may, notwithstanding the above arguments, be thought deserving of the old name *squillarum.*

Bopyrus Fougerouxi, Giard and Bonnier, 1890, in *Leander serratus* (Pennant), from which the '*Bopyrus squillarum*' of the 'British Sessile-eyed Crustacea' was obtained.

Bopyrus Rathkei, Giard and Bonnier, 1890, in *Palæmon rectirostris*, Zaddach.

Bopyrus treillianus, Giard and Bonnier, 1890, in *Palæmon treillianus*, Risso.

Bopyrus xiphias, Giard and Bonnier, 1890, in *Palæmon xiphias*, Risso.

Bopyrus palæmonis, Risso, a doubtful species in *Alpheus* sp. (?)

Bopyrus (?) *alphei*, Fritz Müller, in a Brazilian *Alpheus* sp.

The *Zeuxo alphei*, Kossmann, 1872, described as an external parasite on the head of an *Alpheus*, may be mentioned here, and perhaps the *Prosthète cannelée* of Hesse, 1861, belongs to this genus.

Probopyrus, Giard and Bonnier, 1888. In the female the pleon has the boundaries of the segments well marked all across the back, and has five pairs of two-branched pleopods. In the male the pleon has five pairs of little tuberculiform pleopods. This freshwater genus is considered to represent an ancestral less degraded form of *Bopyrus*.

Probopyrus ascendens (Semper, 1880), in *Palæmon ornatus*, Olivier, which in the Philippines inhabits streams up to 4,000 feet above the sea-level.

Probopyrus palæmoneticŏla (Packard), in *Palæmonetes vulgaris*, Stimpson, of North America.

Probopyrus Giardi, Max Weber, 1892, on *Palæmon placidus*, de Man.

Bopyrina, Kossmann, 1881. The first antennæ are relatively strong in both sexes, especially the basal joint, which in the female works upon the skin of the host. In the adult the second antennæ are reduced to a rudiment. The pleon in both sexes is feebly segmented, in the female with short sack-like appendages, in the male without any. The first pair of marsupial plates are colossal, the rest rudimentary.

Bopyrina virbii (Walz), 1881, on '*Virbius*' *viridis*, Otto.

Bopyrina ocellata (Czerniavsky), 1869, on '*Virbius*' *gracilis*, Heller.

Bopyrina nitescens, Giard and Bonnier, 1890, on *Athanas nitescens*, Leach. The authors think the species may belong to some genus distinct from *Bopyrina*, and merely name it to call attention to it.

Bopyrina hippolytes, Giard and Bonnier, 1890, on *Hippolyte Cranchii*, Leach (?). This species also appears to be at present only nominal.

With regard to the genus *Virbius*, the reader may refer

back to chapter xvii., page 235. *Bopyrina virbii*, corresponding with the figure of the young female given by Kossmann in the 'Zeitschrift für Wiss. Zool.' Bd. 35, pl. 34, fig. 6, 1881, has been found lying across the hind dorsal margin of the carapace of *Hippolyte varians* taken at Ilfracombe. From the conical mouth-apparatus protrude a pair of denticulate lancets, the points of the mandibles.

Bopyroides, Stimpson, 1864. Formed for those species that agree in shape and structure with *Bopyrus*, but differ in their branchial features in having merely fleshy ridges instead of laminæ, with the segments of the pleon distinct. See 'History of British Sessile-eyed Crustacea,' vol. ii. p. 223.

Bopyroides acutimarginatus, Stimpson, 1864, on *Hippolyte brevirostris*. Stimpson also thinks that *Bopyrus hippolytes*, Kröyer, should be placed in this genus. By Bate and Westwood that is called *Gyge hippolytes* (Kröyer). Kröyer's species was taken on *Hippolyte polaris*. The host of the British form is not named.

Hemiarthrus, Giard and Bonnier, 1887. The authors say, 'It is impossible to leave in the genus *Phryxus* the parasites of the abdomen of *Virbius* and *Hippolyte*. These animals differ much from the *Phryxus* type, alike in the female and in the male, which has all the pleon-segments free and furnished with rudimentary limbs. We have established for these Bopyrians the genus *Hemiarthrus*.' In the promised continuation of their great work on the Bopyridæ, no doubt the obscure relations between this and some of the preceding genera will be illuminated.

Hemiarthrus typtonis, Giard and Bonnier, 1890, on *Typton spongicola*, Costa.

Hemiarthrus philonīka, Giard and Bonnier, 1890, on *Nika edūlis*, Risso.

Hemiarthrus virbii, Giard and Bonnier, 1890, on '*Virbius' viridis*, Otto.

Hemiarthrus Cranchii, Giard and Bonnier, 1890, on *Hippolyte Cranchii*, Leach (?). This and the preceding species answer to what Walz has called *Phryxus abdominalis*, Kröyer.

Hemiarthrus abdominalis (Kröyer), 1840, on *Hippolyte Gaimardii*, Milne-Edwards. Kröyer states that he also found it on *Hippolyte Sowerbei* and another nearly related species. J. Sp. Schneider assigns it also to Kröyer's *Hippolyte turgida* and *pusiola*, and to *Pandalus Montagui*, Leach. Bate and Westwood speak of it as a parasite both of the *Pandalus* and of a species of *Hippolyte*. The full-grown female is of remarkable appearance, from her want of symmetry, her great marsupial plates enclosing a vast number of eggs, and the condition of her limbs, which form on one side a little crowded row, while on the other all have disappeared except the first. *Hippolyte Sowerbei* or rather *Sowerbæi*, Leach, is a synonym of *Spirontocaris spinus* (Sowerby), and stands therefore in the genus to which the species *pusiola* and *Gaimardii* have also been recently transferred (see pages 235, 236).

Phyllodūrus, Stimpson, 1857, is thus described by Stimpson, in Latin which if not pedantically classical, has at least the merit of being very easy for English readers to follow :—' Feminæ pedes thoracis sat validi, toti ancorales, unguiculati; appendicibus branchiales carentes. Appendices abdominis branchiales; superiores laterales, laminis duabus æquis magnis elongatis; inferiores papilliformes. Abdominis segmentus primus setis dorsalibus unguiculatis instructus.'

Phyllodurus abdominalis, Stimpson, 1857, from between the abdominal feet of the common *Upogebia*, Puget Sound. On the position of this species the recent authorities do not appear to express any opinion. The other Epicarids of *Upogebia*, *Ione* and *Pseudione*, are referred to the branchial cavity.

At the conclusion of this long catalogue it may be allowable to express a hope that its utility to the student will be in some measure proportionate to the time and trouble expended on producing it. It would have been easy to sacrifice the useful to the ornamental, and instead of showing the extent of the subject, to dwell only on the singularities, indulging in a disquisition on the extremely eccentric and abnormal forms included in this

group. With attention directed to the number of species actually existing, it is probable that the half-score described by Bate and Westwood as belonging to the British fauna will soon prove to be but the nucleus of a far larger company. By accepting the view that no parasite has more than one species of host, we may greatly simplify the otherwise bewildering task of naming specimens, and so far leave the mind at leisure to grapple with the other numerous and intricate difficulties connected with this little-known tribe.

CHAPTER XXVII

TRIBE VII.—ONISCOIDEA

This tribe consists of the land Isopods, adapted for breathing air, but probably in all cases requiring that the air should be humid. In general uniformity and regularity of shape they are strikingly contrasted with the preceding parasitic tribe. The head is small, the seven segments of the peræon are distinct, the pleon is narrower, and usually has six distinct segments, of which the sixth is the smallest. The first antennæ never have more than three joints, and may have fewer, or may be wholly wanting. The mandibles are without 'palp.' The inner plate of the first maxillæ bears either two or three plumose setæ. The second maxillæ have two plates or only one. The maxillipeds are occasionally seven-jointed, but seldom more than four-jointed. The seven pairs of trunk-feet are similar to one another; the hinder more or less exceeding in length those that precede; all are gressorial. The pleopods are branchial. Of the five pairs rarely the first is obsolete; the second and sometimes also the first have sexual organs in the male. The uropods are of variable character, never powerful organs; their branches are single-jointed. Five families are included in the tribe, the Ligiidæ, Tylidæ, Helleriidæ, Oniscidæ, and Armadillididæ.

Family 1.—*Ligiidæ.*

The pleon consists of six segments, of which the first two are narrower than the third. The first antennæ are small, three-jointed. The first maxillæ have three setæ on the inner plate. The second maxillæ have two plates.

In the five pairs of pleopods the outer branch is opercular, the inner branchial, but sexual in the first two pairs of the male. The uropods are produced beyond the apex of the pleon. The young are said to quit the mother with only six pairs of trunk-feet. The family contains seven or eight genera.

Ligia, Fabricius, 1798, has a multiarticulate flagellum to the second antennæ, the maxillipeds with a small rounded epipod, and the 'palp' four- to five-jointed. The uropods have two equal, stiliform, often filiform, branches. *Ligia oceanica* (Linn.) is found on rocky shores of Great Britain and in many parts of northern and western Europe. The uropods are not unlike those of *Asellus aquaticus*. It attains a length of more than an inch, without including uropods and antennæ. In *Ligia exotica*, Roux, the second antennæ are longer than the animal, the flagellum having from twenty-seven to forty-one joints. *Ligia cursor*, Dana, from Valparaiso, hints by its specific name at what is rather a character of the genus, rapidity of running. Von Siebold says that in Japan on rocky shores at ebb-tide in summer the Ligiæ are sometimes so abundant that the fishermen sweep them with brooms into pots, to be used for bait. Budde-Lund in 1885 describes in all twelve species from the shores of various parts of the world, and gives the names of five others. *Ligia dilatata*, Perty, he renames in 1879, *Stymphălus dilatatus*, and he includes Dana's *Styloniscus*, with its three species, in this family.

Ligidium, Brandt, 1833, has a multiarticulate flagellum to the second antennæ, the 'palp' of the maxillipeds conical, five-jointed, the stem of the uropods obliquely produced on the inner side, and the inner branch tipped with two hairs. Five species have been described. *Ligidium hypnorum* (Cuvier, 1792) has had several names. In England it has hitherto only been recorded from the borders of Surrey and Sussex. Budde-Lund supposes that the Bavarian species *Zia paludicŏla*, Koch, and *Zia melanocephăla*, Koch, belong to this genus.

Trichoniscus, Brandt, 1833, has the flagellum of the

second antennæ from two- to seven-jointed, the 'palp' of the maxillipeds obscurely two- to three-jointed, the branches of the uropods subequal or the inner thinner and rather shorter than the outer. *Trichoniscus pusillus*, Brandt, is identified with the British *Philougria riparia* (Koch), *Trichoniscus viridus*, Koch, with the British *Philougria virida*, and *Trichoniscus roseus*, Koch, with the *Philougria rosea*, which not only occurs in many parts of England and other European countries, but has been taken by Mr. Chilton in New Zealand. The first two are little agile brown species; the third is especially attractive by its delicate rose colour, a tint so unusual in this tribe. Budde-Lund describes two other species, and names four more, one of the latter being the *Scyphacella arenicola*, S. I. Smith, of the United States. Dollfus describes four new species, two being from the Azores, one from Tristan da Cunha, and one from Valparaiso.

Haplophthalmus, Schöbl, 1860, has the flagellum of the second antennæ three-jointed, the legs shorter than in *Trichoniscus*, and the pleon less abruptly narrower than the peræon. The last character it shares with Smith's *Scyphacella*. The two species are *Haplophthalmus Mengii* (Zaddach), and *Haplophthalmus danicus*, Budde-Lund, both of them white.

Oligoniscus, Dollfus, 1890, is distinguished from *Trichoniscus*, because, the head being bent forward, the frontal line encroaches on the facial region, and because the eyes are simple. The specific name of the type-species, *Oligoniscus monocellatus*, from Juan Fernandez, corresponds in meaning with *Haplophthalmus*, the name of the preceding genus, from which it seems but little remote.

Titanethes, Schiödte, 1849, has no eyes, the flagellum of the second antennæ multiarticulate, the 'palp' of the maxillipeds three-jointed, the uropods with conical, stiliform, unequal branches. *Titanethes albus* (Koch) is the type. Five other species have been recorded. The genus appears to be confined to caverns.

Family 2.—Tylidæ.

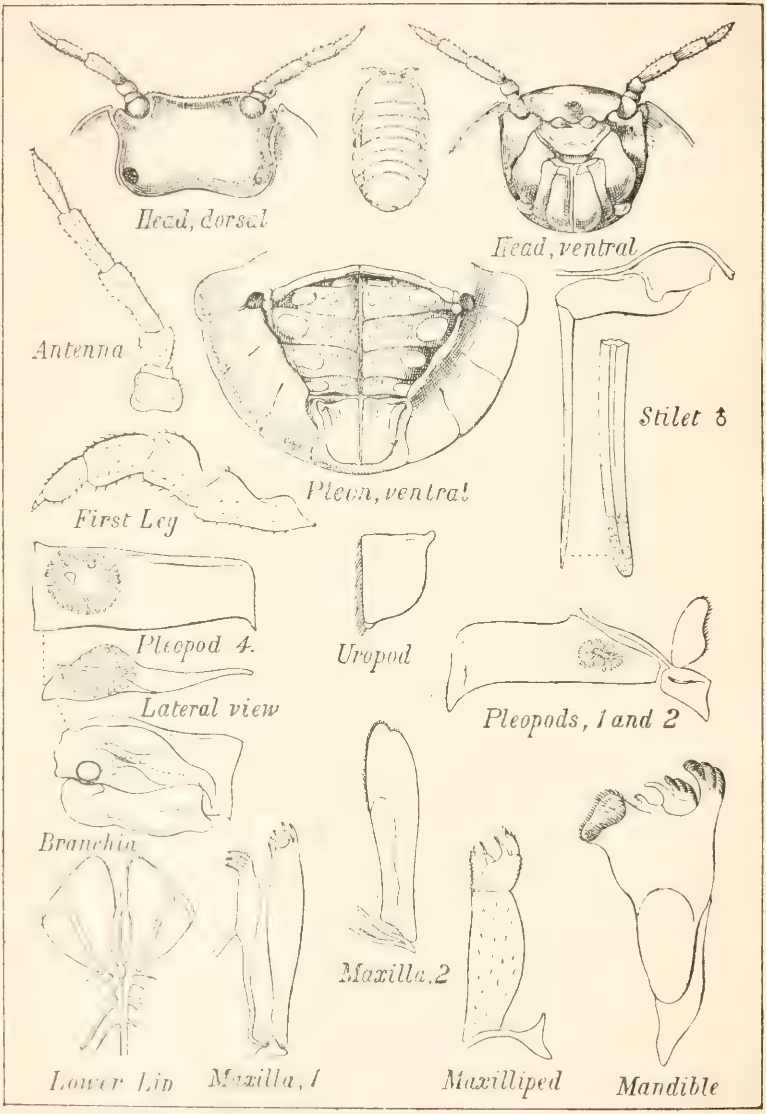
The segments of the peræon, except the first, have the side-plates marked off by a distinct suture. The pleon consists of six segments, of which the first two are very short and narrow. The first antennæ are small, adpressed, one- to two-jointed. The components of the mandibular spine-row are numerous. The first maxillæ have three setæ on the inner plate. The second have only one plate. The 'palp' of the maxillipeds is two-jointed. The first pleopods are wanting (or retain a doubtful rudiment in the male). The second, third, fourth, and fifth pairs are, according to Budde-Lund, all branchial, single-branched. Von Ebner, however, says:—'The peduncular plates of the branchiferous caudal appendages in *Tylos* are not essentially different from those of other Oniscoida; they carry as well the branchial-operculum as the branchial-sack.' Of the respiratory apparatus in this family, he remarks:—'The four developed branchial-opercula all contain ramified air-cavities. These consist essentially of a sack enclosed between the two leaves of the branchial-operculum, which divides into a number of microscopic cæcal tubes. Quite similarly constructed air-cavities occur also on the two first, often on all, of the branchial-opercula of other Oniscoida. These, however, are distinguished from those of the Tylinæ, by the circumstance that it is not openings of the under surface of the operculum, but cross slits on its hinder margin, that lead to them.' The uropods of the Tylidæ are something like those of the Valvifera, but here the folding doors form an operculum not over the pleopods but over the anal opening of the telson; they carry a minute single branch, and are completely covered dorsally by the terminal segment of the pleon.

Tylos, Audouin, 1825? This being the only genus has the characters of the family. The first verbal description was printed by Audouin in his 'Explication sommaire des planches des Crustacés de l'Égypte et de la Syrie.' He states that *Tylos* was a manuscript name given to the

genus by Latreille, and points out that the figures of the type-species, *Tylos Latreillii*, Audouin, in Savigny's Plate, show the generic characters. Latreille in his 'Familles naturelles du Règne Animal,' p. 567, 1825, merely says, 'Ajoutez immédiatement après le genre *lygie*, TYLOS (nouveau genre composé d'espèces marines),' so that the information he offers is incorrect. Thus Savigny gave no name; Latreille gave a name, but did not effectively publish it; Audouin published the name, with a description; the genus must therefore belong to him. But there is still a difficulty. In 1826 the name *Tylos* was given by Van Heyden to a genus of Arachnida, and Budde-Lund assigns Audouin's 'Explication' to 1827. M. Eugène Simon, however, has explained that Van Heyden's prodromus on the classification of the Acari merely named without defining the genus, and therefore did not effectively pre-occupy the name *Tylos*. But Audouin's preface is dated 1825, and it seems possible, therefore, that the Crustacean genus was really published in advance of the Arachnid. M. Simon, on the contrary, says that the name *Tylos armadillo*, Latreille, 1829, was published before the *Tylos Latreillii* of Audouin's 'Explication,' which can scarcely be correct. Budde-Lund describes, besides the typical Mediterranean species, six others, including two made known by Krauss from South Africa. *Tylos spinulosus*, Dana, is mentioned, and *Tylos granulatus*, Miers, from Japan, is distinguished from Krauss's African species of the same name, as *Tylos granuliferus*.

Family 3.—*Helleriidæ*.

The peræon is as in the preceding family. The pleon has the first five segments fused, with two pairs of short lateral sutures marking off the third from the fourth, and the fourth from the fifth segment. The terminal segment is short, subquadrate. The first antennæ are wanting. The spine-row of the mandibles has but two components on the left mandible, and is reduced to one on the right. The two pairs of maxillæ and the maxillipeds have the



Helleria brevicornis, v. Ebner

characters ascribed to them in the preceding family. The first pleopods are absent or reduced to widely separated rudiments, of doubtful homology. The pleopods of the second, third, fourth, and fifth segments are two-branched; the second pair have the usual stilets in the male. On each opercular plate there is a roundish air-cavity placed near the outer margin, with a single opening in each operculum of the second pleopods, but two openings in those of the three following pairs. According to von Ebner, the peduncle in the pleopods forms a part of the branchial sack, so that the two branches instead of being freely articulated with it are fastened direct to the segment. The uropods are similar to those in the Tylidæ, but are attached at the front corner of the outer margin instead of at its centre. The minute terminal joint is considered to be the outer branch.

Helleria, Ebner, 1868, is the only genus, and *Helleria brevicornis*, Ebner, the only species. It occurs in Italy, and in the mountain forests of Corsica in damp moss; also M. Chevreux has recently sent it me from Cap d'Antibes out of his own garden. In 1879 Budde-Lund changed the name *Helleria* to *Syspastus*, because other genera of Crustaceans have received the name *Helleria*, but these other genera, as M. Chevreux has pointed out, were named not *before* but *after* the publication of von Ebner's genus. It would be absurd that Dr. Camil Heller should be entirely deprived of the honour intended him, through the fact that so many of his friends had separately endeavoured to render it. Without question von Ebner's genus must retain its original name, and, with the cancelling of *Syspastus*, Budde-Lund's family 'Syspasti' naturally suffers a corresponding change into Helleriidæ. The figures on Plate XIX. are copied from von Ebner's paper.

Family 4.—Oniscidæ.

The animal is seldom very convex or capable of easily assuming a globular form. 'The head is little broader than long, and not clearly flanked by the first segment of the

peræon; the face is sloping. The sides of the head are distinctly marked by a vertical marginal line and an inframarginal line. The clypeus is arched.' The pleon has six segments, of which the first two are narrower and usually shorter than the third. The young quit the mother with the seventh segment of the peræon still undeveloped. The first antennæ are three-jointed. The second antennæ have the flagellum from two- to four-jointed. The first maxillæ have two plumose setæ on the inner plate; the second maxillæ have two plates; the 'palp' of the maxillipeds is two-jointed, the epipod oblong, acute. The trunk-feet are rather long. In the first and second pleopods of the male the inner branches form long narrow sexual organs, those of the first pair often coalesced; in the female the same branches are rudimentary, short, acute. In the remaining pairs the inner branch is branchial; in all the pairs the outer branch is opercular, and often also tracheal. The uropods are always prolonged beyond the two terminal segments of the pleon.

Budde-Lund, in his exceedingly valuable work on the Terrestrial Isopoda, makes a family Onisci, which he divides into two sections, Armadilloidea and Oniscoidea, but it seems better to constitute two families, since it is the almost invariable fate of large sections eventually to be made independent. For the Oniscidæ, or second section, Budde-Lund gives a tantalising 'Conspectus Generum,' based on the flagellum of the second antennæ, on the tracheal or non-tracheal character of the pleopods, and on the uropods.

I. Flagellum 2-jointed.	
A. With tracheæ.	1. *Porcellio.*
B. Without tracheæ.	2. *Platyarthrus.*
II. Flagellum 3-jointed.	
A. With tracheæ.	3. *Scleropactes.*
B. Without tracheæ.	4. *Oniscus.*
III. Flagellum 4-jointed.	
A. Uropods short.	5. *Armadilloniscus.*
B. Uropods elongate.	6. *Deto.*

Any enjoyment that might be derived from the sweet

simplicity of this arrangement is rather rudely disturbed, when it appears that *Porcellio* has to be divided into seven genera or sub-genera and *Oniscus* into five, and in fact with one or two recent additions the Oniscidæ contain twenty-one genera instead of only six. Little more can be done here than to mention their names.

Porcellio, Latreille, 1804. In this genus, after restriction, Budde-Lund describes seventy-one species, besides giving the names of more than a score recorded without description or imperfectly described. To this long list additions have since been made, as *lamellatus*, Uljanin, from the Mediterranean and the Azores; *cristatus*, Dollfus, from Surinam; *Marioni*, Aubert and Dollfus, from Marseilles; *provincialis*, Aubert and Dollfus, from Salon, in one of the districts of Provence, the most arid and remote from human habitations. Moreover, four or five new species from Syria, chiefly collected by Dr. Th. Barrois, have been named by M. Dollfus during the year 1892. Only the following four species out of this extensive genus have been recorded in Great Britain. 1.—*Porcellio scaber*, Latreille, is extremely common over the whole of northern and central Europe and the North of America. It extends to Greenland, and none of the land Isopoda range further to the north than this does. It is said also to reach the Cape of Good Hope and to have been found in Central America. 2.—*Porcellio pictus*, Brandt, is perhaps the same as the earlier *Porcellio spinicornis*, Say. It is distinguished by a large apical tooth on the second joint of the second antennæ, and by the black and yellow markings of the peræon. Together with the preceding species it belongs to a section of the genus in which the last segment is triangularly produced, with a sharp apex. 3.—*Porcellio dilatatus*, Brandt, belongs to a section in which the last segment is produced with a rounded apex. It does not appear to be at all common in Great Britain. 4.—*Porcellio lævis*, Latreille, belongs to a group distinguished from that which includes all the other three by having the hind margins of the first three peræon-segments less laterally sinuate, the side-plates less, with the hinder angles in the earlier segments

more obtuse, scarcely prolonged backwards, with the lateral process small, obtuse or none. All the four species agree with the species found in Syria in belonging to the division of the genus in which there are two pairs of tracheæ, as distinguished from another division in which there are five pairs. The extensive distribution of *Porcellio lævis* is emphasised by Budde-Lund in the words 'Patria: Orbis terrarum.' It was obtained by the *Challenger* at Bermudas, the Cape Verde Isles, and at Honolulu. M. Adrien Dollfus observes that while *Porcellio scaber* is abundant in the cold and temperate regions both north and south, but not in the tropics, *Porcellio lævis* appears to have followed man all round the world except in the cold regions of the two hemispheres.

Cylisticus, Schnitzler, 1853, has the body more convex and contractile than it is in the preceding genus. The branchial-opercula of all five pairs of pleopods are furnished with tracheæ. *Cylisticus convexus* (De Geer) has priority over the name *Porcellio armadilloides*, Lereboullet, used in the 'British Sessile-eyed Crustacea.' Budde-Lund describes seven species of *Cylisticus*.

Hemilepistus, Budde-Lund, 1879, is notable for ample sculpture with spines or coarse granulation on the front part of the body, of which, however, the young ones are devoid. Budde-Lund describes ten species, all of which are found in the sandy deserts of Africa and Asia. One of them, *Hemilepistus ruderalis* (Pallas), was described by Pallas in 1771. The first and second pleopods, and more rarely the third or all are provided with tracheæ.

Metoponorthus, Budde-Lund, 1879, meaning 'with a straight front,' is frequently mis-spelt *Metoponorthrus*, to which no intelligible meaning could be assigned. Budde-Lund gives descriptions of thirty-five species. In this genus is included *Metoponorthus cingendus* (Kinahan) found in the coast regions of England and Brittany, but distinct from the species so named by Budde-Lund from the highlands of the South of France, which Dollfus has therefore renamed *Metoponorthus meridionalis*. This has three pairs of tracheæ, whereas Kinahan's species has only

two pairs. Another British species, which is said to be cosmopolitan, is *Metoponorthus pruinosus* (Brandt). It belongs to the section with two pairs of tracheæ. Mr. Whymper found it in Ecuador at a height of 13,300 feet above the sea, highest soaring of the Isopoda. Dollfus describes *Metoponorthus Barroisi*, 1889, from the Azores, and in 1892 two new species from Palestine.

Rhyscotus, Budde-Lund, 1885, has a single species, *Rhyscotus turgifrons* from the West Indies.

Leptotrĭchus, Budde-Lund, 1879, 'with fine hairs,' receives four species, to which Dollfus doubtfully adds his Syrian *Porcellio pulchellus*. He also records *Leptotrichus tauricus*, Budde-Lund, from the Mount of Olives.

Bathytrŏpa, Budde-Lund, 1879, 'with deep haunts,' has two or three species.

Lucasius, Kinahan, 1859, is reinstated by M. Eugène Simon in 1885, to receive not only the Algerian *Porcellio myrmecophĭlus*, Lucas, for which it was instituted by Kinahan, but also three other species, *pallidus*, *tardus*, and *pauper*, named by Budde-Lund and by him referred to *Porcellio*. In 1890 Dollfus likewise remarks that *Lucasius* ought to be extended to a whole group of the ancient genus *Porcellio*, formed of ant-loving species, with characters morphological and biological near to those of *Platyarthrus*. He describes a new species *Lucasius hirtus* from Marseilles, and from the same district records *Lucasius pallidus* (Budde-Lund).

Chavesia, Dollfus, 1889, agrees with the preceding genera in having the flagellum of the second antennæ two-jointed, but with *Armadilloniscus* more nearly in the structure of the uropods. *Chavesia costulata*, Dollfus, is from the Azores. By an obvious misprint the description assigns the two-jointed flagellum to the first antennæ.

Platyarthrus, Brandt, 1833, has the body broad and flattened, no eyes, the flagellum of the second antennæ small, with its first joint inconspicuous. *Platyarthrus Hoffmannseggii*, Brandt, appears to be met with almost all over Europe, but never except in ants' nests. In addition to the English localities named by Bate and Westwood,

there may be mentioned Tenby, Ventnor, Tunbridge Wells, and Cissbury Camp near Worthing. Probably the little white slow-moving woodlouse finds its food in the formicarium, and pays for its board and lodging by acting as a scavenger. The ants when disturbed leave their guests to shift for themselves, and do not carry them off along with their own helpless larvæ. There are two other species of the genus, one of them a cave-dweller.

Oniscus, Linnæus, 1767, occupies now a humble and limited position in the sub-order of the Isopoda, the whole of which it at one time embraced. *Oniscus asellus*, auctorum, is very common throughout Europe and in North America. There seems no reason to relinquish the specific name in favour of the later *Oniscus murarius* of Cuvier. The other species found in Great Britain, *Oniscus fossor*, Koch, is smaller, duller in colour, and more closely tuberculate. *Oniscus Simonii*, Budde-Lund, occurs in the South of France; *Oniscus punctatus*, G. M. Thomson, in New Zealand.

Philoscia, Latreille, 1804, to be pronounced Philoskia, and meaning 'a lover of shade,' has a name which would probably be appropriate to every genus in this sub-order. Budde-Lund gives the description of twenty species, with the names of three more. That which he describes as *Philoscia longicornis* is in fact *Philoscia Couchii*, Kinahan, a maritime species which he elsewhere supposes possibly to belong to *Ligidium*. Besides inhabiting the coasts of Devon and Cornwall, *Philoscia Couchii* appears to be found all round the Mediterranean. It runs fast and is very shy. The body is smooth as in the rest of the genus, and the integument is not very firm. *Philoscia muscorum* (Scopoli) is very common in the South of England and in many parts of Europe. Budde-Lund says that Leach was mistaken in saying that it had been found in Sweden. *Philoscia pubescens* (Dana) is found in New Zealand. *Philoscia pulchella*, Budde-Lund, is identified by Dollfus with his own earlier described *Philoscia elongata*. Dollfus also establishes *Philoscia corsica*, 1888, inhabiting the

mountain forests of Corsica, a 'beautiful species, hitherto the largest of the genus,' *Philoscia celleria*, 1884, from Marseilles, and *Philoscia anomala*, 1890, a species brought by the *Challenger* from Valparaiso and Juan Fernandez, in which the adult male, perhaps in the marital stage, has the fifth joint (tarsus) of the fourth pair of feet developed into an almost circular disc. Dollfus remarks that *Oniscus bucculentus*, Nicolet, is really a *Philoscia*, which also exhibits this apparently anomalous and perhaps temporary character.

Alloniscus, Dana, 1854, has seven species described by Budde-Lund, of which the first is *Alloniscus perconvexus*, Dana, from California; the last is *Alloniscus cornutus*, Budde-Lund, strongly exhibiting the generic character in having the lateral frontal processes of the head large, narrow, prominent, subconical, and the middle of the front very tumid. In addition to the seven species, *Rhinoryctes mirabilis*, Stuxberg, 1875, from California, is said certainly to belong to *Alloniscus*.

Lyprobius, Budde-Lund, 1875, receives three species.

Scyphax, Dana, 1852, has the species *setiger*, Budde-Lund, from New Caledonia, and *ornatus*, Dana, from a sandy beach of New Zealand.

Deto, Guérin, 1834, is said to be very near *Oniscus*. *Deto echinata*, Guérin, and *Deto acinosa*, Budde-Lund, are both African species.

Armadilloniscus, Uljanin, 1875, has the flagellum of the second antennæ four-jointed. Budde-Lund, besides describing three species, incorporates with them *Actoniscus ellipticus*, Harger, and with hesitation also *Actæcia euchroa*, Dana, and *Actæcia Aucklandiæ*, G. M. Thomson, both from New Zealand. Dollfus adds *Armadilloniscus tuberculatus*, 1889, from the Azores. In this genus the uropods are flattened and scarcely produced, the peduncle large, and the outer branch short, just reaching the apex of the peduncle.

Scleropactes, Budde-Lund, 1885, has the body very convex and contractile into a globular form, the opercular branch in all the pleopods tracheal, and the uropods toler-

ably produced with a short outer branch. The three species described by Budde-Lund are from Peru.

Budde-Lund mentions *Acanthoniscus spiniger*, White, from Jamaica, and *Ourachærus caudatus*, White, of unknown habitat, but confesses himself unable to determine their position among the Onisci.

Stenoniscus, Aubert and Dollfus, 1890, does not fall into any of the groups established or recognised by Budde-Lund. It has a very narrow, hairy body, the hind margin in the front segments of the peræon not sinuous, and but little in the hinder ones, the side-plates distinct in all but the first segment; the first segment of the pleon not visible, the others dorsally tubercled, the large rounded terminal segment completely covering the uropods, which have a broad short peduncle, the outer branch apical, minute, the inner longer than the outer, attached high up on the peduncle. The second antennæ are very short, with a two-jointed flagellum. The single species is *Stenoniscus pleonalis*, Aubert and Dollfus, from the sea-coast, Marseilles.

Family 5.—*Armadillidiidæ*.

The body is very convex, contractile into a globular form. The head is sometimes broader than long, flanked by the first segment of the peræon; the face is nearly perpendicular. There is no demarcation of the sides of the head. The clypeus is perpendicular. The young quit the mother with all seven segments of the peræon developed. The trunk-feet are rather short. The uropods are short, flattened, not reaching beyond the postero-lateral points of the two terminal segments of the pleon. The foregoing characters distinguish this family from the Oniscidæ, the other characters of which are common to both families and need not be repeated.

Of the generic names in this family the nearest in age to the preoccupied *Armadillo* are *Cubaris* and *Armadillidium*. Of these two, which are contemporaries, it seemed reasonable and convenient, for the sake of old association, to give the preference to *Armadillidium* in forming the name of the family.

Budde-Lund gives in effect the following 'Conspectus Generum:'—

I. Outer branch of the uropods small or minute, rather smooth.

A. Terminal segment not shorter than the uropods.

a. Terminal segment apically truncate.

1. *Cubaris.* 2. *Eubelum.* 3. *Pseudarmadillo.*

b. Terminal segment apically acuminate.

4. *Peryscyphis.*

B. Terminal segment shorter than the uropods, broadly triangular.

5. *Sphæroniscus.* 6. *Cylloma.*

II. Outer branch of the uropods large, flattened, lamellar.

7. *Eluma.* 8. *Armadillidium.*

Cubaris, Brandt, 1833, appears to be the earliest synonym of *Armadillo*, Latreille, 1804, which is not only preoccupied, but has had the type-species removed to another genus. Under the name *Armadillo*, Budde-Lund gives descriptions of thirty-six species, and the names of some twenty-four more. Only two or three of this host are found in Europe, seven belong to South Africa, five to South America, a great number occur in the islands and coasts of the Pacific, while from the whole mainland of Asia not one is known, except *Cubaris officinalis* (Desmarest), a species found all round the Mediterranean. Dollfus adds *Armadillo melanurus*, 1887, *Armadillo javanensis*, 1889, *Armadillo trifolium*, 1890, and *Armadillo albomarginatus*, 1892. In this genus the flagellum of the second antennæ is two-jointed.

Eubelum, Budde-Lund, 1885, has the flagellum of the second antennæ three-jointed, the last segment of the pleon in the middle squarely produced. As in the preceding genus the opercular branch in all the pleopods is tracheal. The only species is *Eubelum lubricum*, from South Africa.

Pseudarmadillo, de Saussure, 1858, has very small, un-

pigmented eyes. The only species is *Pseudarmadillo carinulatus* from Cuba or Mexico.

Peryscy̆phis, Gerstaecker, 1873, has three species, *Peryscyphis trivialis*, Gerstaecker, from an East African Lake, and two others from Egypt, for which at first Budde-Lund established a new genus *Cercocytonus*, which he cancels in the same volume. The meaning of *Cercocytonus* is obscure. Probably *Cercoxytŏnus* was intended, meaning with acuminate tail. *Peryscyphis* was no doubt a misprint for *Periscyphis*, the name alluding to the convex form of the animal.

Sphaeroniscus, Gerstaecker, 1854, has small eyes, the second antennæ short, with a three-jointed flagellum. The single species is *Sphæroniscus flavomaculatus*, from New Granada. Budde-Lund thinks that *Pyrgoniscus cinctutus*, Kinahan, 1859, from Eastern regions, may belong to this genus.

Cyllōma, Budde-Lund, 1879, has very large prominent eyes, the third joint of the first antennæ very long, all the pleopods with tracheal opercula. The single species *Cylloma oculatum* is from New Zealand.

Elūma, Budde-Lund, 1879, has simple, minute eyes, the flagellum of the second antennæ two-jointed, the opercular branch of the first and second pleopods tracheal, the terminal segment of the pleon subtriangular, the uropods reaching beyond this, but not beyond the postero-lateral angles of the preceding segment; the outer branch of the uropods is flattened, laminar. The type is *Eluma purpurascens*, Budde-Lund, 1879, from Madeira, the Azores, Algeria, and Portugal. It is possible that this is synonymous with the earlier *Armadillidium cœlatum*, Miers, 1877.

Armadillidium, Brandt, 1833, has the flagellum of the second antennæ two-jointed, the opercular branch of the first and second pleopods tracheal, the terminal segment of the pleon with the apex variable, not produced beyond the angles of the preceding segment, the uropods not reaching beyond the terminal segment. Budde-Lund describes thirty species, and names eight others attributed to this genus. Dollfus in 1887 adds five new French species, *Simoni*,

esterelanum, *sordidum*, *alpinum*, *album*, and two others named *Kochi* and *Davidi*. Of all this crowd only one species, *Armadillidium vulgare* (Latreille), appears to be known in Great Britain, and this species seems to be gradually following the track of Europeans all over the world.

From Assinee in West Africa, M. Adrien Dollfus has just recorded two new genera and four new species of this family. His *Synarmadillo clausus* is near to *Cubaris*, but distinguished from it by having the terminal segment of the pleon after the fashion of *Armadillidium*. His *Mesarmadillo* is intermediate between the same two genera, and with its three species, *Alluaudi*, *marginatus*, and *tuberculatus*, appears to belong to the section I. B. of Budde-Lund's Conspectus. As observed in *Alluaudi*, the second maxillæ are said to be exceptionally large.

In a paper on the terrestrial Isopoda of Spain, M. Dollfus has further added several new species to this and the preceding family.

It may be useful here to call attention to the remarks which the same author has recently made as to the head of a woodlouse. The hinder part or top he calls the *occiput*. The anterior part comprehends, first, the *vertex*, 'generally forming a right angle or an obtuse angle with the occiput, from which it is *always* separated by a more or less strongly defined ridge;' secondly, the *epistome*; thirdly, the *labrum* attached to the epistome. The face is said to be sloping, when the occiput and vertex form an obtuse angle, perpendicular, when they form a right angle. Occasionally the occiput itself is bent forwards and then its front part must not be confounded with the vertex, from which it is separated by the usual boundary.

CHAPTER XXVIII

CONCLUSION

To complete the sketch of the Malacostraca, the sub-order of the Amphipoda remains to be described. These crustaceans may be defined in a very simple manner as Edriophthalma having branchial sacs or vesicles connected with some or all of the last six of the seven pairs of limbs normal to the peræon or trunk. Of all the divisions of the sub-order which have been proposed, that which arranges them in three tribes, the Gammaridea, Caprellidea, and Hyperidea, still seems the most satisfactory. Chapters describing these tribes for this volume had been already written, when it appeared that they overflowed the utmost space that could be allowed. As room for them could only be found by an unsatisfactory curtailment of the earlier portions of the work, I have preferred to leave over this last section of the Malacostraca, hoping to engage the reader's interest in it at no distant future.

For the exclusion of a group so important as the Amphipoda, and one so obviously within the scope of the present pages, an apology is doubtless due, but little or none need be offered for the omission of much else which the student might desire to know, since the extent of the subject and the limits of the volume must make it clear that no other course was possible. It would take a volume by itself to analyse in an effective manner the long and valuable disquisitions which have been written on the circulation, the nervous system, the viscera, the tissues, the intimate structure of the various organs of the senses, the connection between fossil and recent forms, and the

difficult questions of genealogy. On all these lines of research knowledge is continually extending. The time may be expected to come when, not from any one of them by itself, but from all combined, a final system of classification will be established. Apart from all these questions the simpler groundwork of the student's knowledge of recent Crustacea will still be incomplete unless the history be extended to those other orders mentioned at the outset, which comprise forms as varied, as strange, as numerous as those of the Malacostraca.

On the literature of the subject not a little that is entertaining might be written. That literature was scanty and unfruitful in classical times. At the restoration of learning it began, amidst idle tales and inexact observations, to lay the solid foundations of science. In the present century it has attained an astonishing development, aided no doubt successively by the perfecting of the microscope, by the extension of marine research, and by an all-pervading desire to arrive at the truth about the origin of species. To illustrate the difference between what was known of the Crustacea at the beginning of the last century and what is known of them at the close of the present, one is tempted to contrast the half-dozen lines which suffice for the whole class in the first edition of Linnæus's 'Systema Naturæ' in 1735, with the four thousand quarto pages and more than six hundred plates employed by the *Challenger* Reports between 1880 and 1888 in the discussion and illustration of a host of crustacean species of which most were previously unknown. The 'System of Nature,' it is true, began in small compass, and was repeatedly expanded in successive editions, but even in the thirteenth, published in 1788, that part of it which may fairly be regarded as a manual of all the Crustacea with which science was at that period acquainted, is swollen only to the extent of fifty-three octavo pages. In 1825 the French writer, A. G. Desmarest, could still confine within the limits of a single volume an able and meritorious survey of the whole subject, but not long afterwards the masterly 'History of the Crustacea,'

by Henri Milne-Edwards, completed in 1840, though perhaps three times as valuable as Desmarest's, was also three times as large. Since that date no work of similar scope has been carried out with any success in smaller compass, nor is it likely now that such a feat could be accomplished. The Jinnee has escaped from the casket, and no magician can ever again reduce its gigantic expansion to occupy the narrow receptacle from which it issued.

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[1] MM. Chevreux and Bouvier have recently confirmed the opinion that the genus *Glaucothoë* represents only larval forms, and they argue that these belong rather to the family Paguridæ than to the Parapaguridæ.

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